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ROYAL AGRICULTURAL SOCIETY

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VOLUME THE EIGHTH.

PRACTICE WITH SCIENCE.

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THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture*

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ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*The Management of Sheep.* By ROBERT SMITH.

PRIZE ESSAY.

SHEEP HUSBANDRY having long engaged my attention as a breeder of male animals, and being fully convinced of the importance of encouraging the present improved and established breeds countenanced by the Society, viz.—the *Leicesters,* the *Southdowns,* and the *Long Wools,* I do not deem it altogether presumptuous in me to compete for the Premium. In doing so I rely solely on the qualification which my motto indicates—"Practice and Perseverance."

Sheep may be found in every quarter of the globe, but are most cultivated in Europe; they inhabit every variety of climate, and adapt themselves to the vicissitudes of heat and cold. In each country they are cultivated, according to the wants and tastes of the people, either for food, clothing, or the uses of commerce; and the management is governed materially by the climates where they are produced. They are impressed at every change with some peculiarity alterable only by a change of situation, and varying (I might almost affirm) with the weather; for where the temperature is equable, there does the animal preserve unchanged an atmospheric stamp, while under a fluctuating sky we can model it at will, though in this case continued exertions are required to maintain it for any length of time in an undeviating course.

In a wild state sheep prefer to range at large upon open fields and plains, and display considerable sagacity in the selection of their food, which suggests the importance of change in their domestic management.

No other animal is, in my opinion, worthy of so much attention as the sheep, it being alike valuable to the farmer and to the nation;—to the farmer, because it is raised with ease, and in situations where other animals could not exist; and in general

makes a better return, for the quantity and quality of food consumed, than any other animal;—to the nation, as supplying a staple article of food, and giving employment to thousands of artisans by the conversion of the wool into manufactures. In fact, the production and general management of sheep claims to be treated as the foundation of good and profitable husbandry.

The production of first-rate sheep is a "science blended with practice;" consequently a proper knowledge of nature's laws (the effect of climate and situation upon the character and disposition of the animals) has led to important improvements in their form, quality of flesh, and general management. As the present "improved breeds" are the production of man's skill and enterprise by propagation from their original state, were the breeders once to relax their exertions, leaving the animals to nature's course, so soon would the various flocks degenerate.

The Leicesters, or what were originally termed the Dishley flock, date their origin from the career of the celebrated Robert Bakewell, of Dishley, in the county of Leicester, whose great abilities, about the year 1755, dictated the cultivation of a style of sheep previously unknown, and by which he subsequently became so distinguished. The precise plans he adopted in procuring the *parent* stock are yet a matter of conjecture, he having maintained great secresy upon the subject: but it is evident, and indeed distinctly known, that by a careful selection of improved animals through repeated generations, he raised a standard approaching to excellence, as well in regard to symmetry and lightness of offals as to propensity to fatten. Mr. Bakewell's sheep became the admiration of surrounding breeders, and were eagerly sought after; but fully to carry out his designs he suggested a plan which was adopted, viz.—the formation of a Society composed of a certain number of the principal breeders, who adopted the "New Leicesters" as an improved breed emanating from the Dishley flock: hence arose the permanent establishment of this valuable breed of animals, which supplied an immense proportion of meat for our increasing population, as well as a beautiful fleece for the middle descriptions of our woollen manufactures. These have been handed down from year to year by the great ability of Bakewell's followers, many of whom have spent an anxious life in their propagation. It is, however, remarkable that, although so many breeders have given their strict attention to the subject, and have had the same conclusions in view, scarcely two have adopted the same course.

Each, in fact, has had his peculiar idea of putting the male and female together, to produce the style of animals which he considered to possess the best essentials for producing the greatest weight of wool and mutton per acre for the amount of food

consumed. Amongst the more popular flocks at the present time are those of the late Mr. Robert Burgess, of Cotgrave Place, Notts; Mr. Creswell, of Ravenstone, Leicestershire; Mr. Bennett, of Bickering's Park, and Mr. Pawlett, of Beeston, Bedfordshire; Mr. G. Turner, of Barton, Devonshire; Mr. Robinson, of Carnaby, and Sir Tatton Sykes, Bart., Yorkshire; Mr. Stone, of Barrow, and Mr. J. Buckley, Normanton Hill, Leicestershire; and Mr. Hewitt, of Dodford, Northamptonshire.

The general practice with the Leicester breeders, in what is termed "setting" their flocks, is to select those ewes which possess the best form, quality of flesh, propensity to fatten, and lightness of offals, with fine long wool. So decided are the best breeders in favour of a symmetrical appearance in their flocks, that many exceedingly good animals are *drafted* in consequence of some little want of uniformity in their general outline, or owing to their possessing some line of blood which has proved injurious. It is not uncommon with the ram-breeders to draft the whole produce from a sheep that has disappointed them, and they are exceedingly cautious in using young sheep that have not been proved, preferring to see their produce, that they may proceed with a degree of certainty. In stating the mode of managing the Leicester flocks, it would be difficult to trace them to any particular locality, as they are to be found in nearly every district of the United Kingdom, though they are principally kept upon the turnip-soils of the midland counties. When the ewes have been selected for breeding, it is usual to give them better keeping, as those ewes which are placed upon fresh keeping take the ram a week earlier than those upon the stubbles.

The rams having also been selected to *suit* the flock, particular attention is paid by the breeders to have ewes drawn to those rams which are best suited to correct their faults.

The general custom is to turn the rams loose with the ewes in the field about the 1st of October. With well-bred animals, however, this is found to be a bad practice, as it too frequently occurs that, in consequence of their high condition, the ewes prove barren. When forward lambs are required, the rams are put with the ewes early in September: by far the better plan, and one which is pretty generally adopted by the most successful breeders, is to keep the rams in a convenient paddock, properly divided, and place a *teazer* with the ewes, which are regularly brought up to the *stocks* as they are noticed, there to be superintended by the shepherd, according to the previous selection and arrangement—a daily register being kept of the proceedings.

When the ewes come up slowly they are served twice; but during the busy part of the season once is considered sufficient, as when the rams are in active work the ewes are more certain to

be with lamb, and produce more couples. The ewes are then turned away into a separate field until the end of a fortnight, when they are again taken back to the teazer; or a fresh one is placed with them, which is the better plan, being then more easily noticed, as they commonly return from the fourteenth to the seventeenth day, if not with lamb. The practice is to mark them with *ochre* every week as they are rammed, commencing the first week under the near ear, then the near shoulder, midside, hip, &c., round to the far ear, which completes the season of eight weeks. By a careful observance of this plan they are readily drawn out from week to week during the lambing season, and it saves both expense and trouble. When the rams are removed, the ewes are dressed with mercurial ointment in the proportion of 2 lbs. to the score, to cleanse them and assist the growth of the wool. The ewes up to this season of the year (and in many situations much longer) are kept upon the grass or meadow lands, where the farms are of that character; but on arable farms with a short proportion of grass-land, they are usually placed upon the turnip-lands, to follow or clean up the peckings after the store-lambs, which are allowed to go forward; and they do exceedingly well. On reference to my own daily register, kept during seven seasons, I find the ewes usually go with young 21 weeks upon an average, but vary slightly from 20 to 22 weeks, and go with male lambs rather longer than with ewe lambs. The ewes are drawn out a fortnight before lambing, and placed upon grass-land, if possible, near home; they are shut up every night in a lambing-yard; a few turnips are thrown to them in the field when convenient, otherwise they are allowed a moderate quantity of corn, with cut hay or clover chaff; when applicable, the ewes are placed upon turnip-lands for a few hours during the day, exercise being very desirable; those that have lambed during the day or night are removed to convenient sheds previously prepared for the occasion, and thence to better quarters, such as a prepared field of rye, or rye and tares mixed with a little coleseed, but more commonly to young seeds or grass-lands which have been rested for them, and there supplied with a few turnips or corn. Upon arable farms it is frequently their lot to be again placed upon the turnip-land, having rock-salt to lick in small iron troughs. Salt is also frequently given with the chaff. In those situations where the breeder has no arable land (which is the case with a great many breeders in Leicestershire) the ewes are placed with the ram much later in the season; they being with these breeders fed entirely, I may say, upon grass throughout the year; but according to my experience it would be far better to supply them with a moderate quantity of corn during the spring or lambing season, as the ewes are then frequently much reduced, which causes great loss during the lambing time, besides stinting the

quantity and quality of wool, and occasionally the dam, offspring, and fleece, are *all* culls in consequence.

In the case of a ewe losing her lamb, it is customary to place the skin of her offspring upon another lamb intended to be put with her. The ewe generally takes to the stranger in a short time; but in the event of difficulty, a little gin rubbed upon the skin of the lamb and nose of the ewe at once effects the desired object.

When lambs are dropped between the visits of the shepherd, it often happens that they are starved and unhealthy. In this case a little gin and the ewe's milk is given them, and they are wrapped up in a fleece of wool and placed before the shepherd's fire. When bound or loose in their bodies, or even apparently unwell, two teaspoonsful of castor-oil, with a little ginger, are given; when swollen joints appear, an embrocation is instantly applied to the part, and opening medicine given. In difficult cases with the ewes in lambing, gruel and treacle are given as support: in cases of pain a small quantity of laudanum and linseed oil. When ewes appear to be swelling, the following receipt has been found of great value:—2 oz. roach alum, 1 oz. white copperas, mixed in a pint and a half of rain-water, kept well corked. Two tablespoonsful is sufficient for one dressing.

Upon turnip and seed-farms, where the object is to raise fat wether lamb-hogs, the management of the lambs is commenced at an early period. They are promoted in regular succession, being first separated from the ewe-lambs and allowed to take precedence throughout the year. It is now the practice to wash and shear the general flocks in the beginning of June (though this is considered by some too early in the season). By this plan they are found less subject to fly-galls, gain more weight during the summer, have a more bulky appearance when sold in the autumn, and there is no difference in the weight of wool, if adopted as a general system. The custom of dipping the lambs directly after the ewes are shorn is in my opinion a valuable one, and should never be omitted. There is also a growing practice of having the whole flock dipped at this period of the year, as it affords an excellent opportunity for cleansing them. The lambs are again dressed with mercurial ointment the first week in October: if this be omitted they are much tormented during the warm spring months. The *weaning* of lambs is considered to be a nice point, as much depends upon its being properly accomplished.

The plan of taking the ewes *from* their lambs to a distant field reserved for them, rather than take the lambs from the ewes, is preferred by these breeders: the lambs being accustomed to their pasture, they remain more quiet than when removed to a strange field, where they fret, become thin and exhausted with bleating,

and too often incur fever and scouring, which are the forerunners of other diseases, and the cause of their doing badly for weeks, if not the whole winter following. The ram-lambs are put with their dams into the clover or reserved spots for some few days previously to weaning, where they learn to eat green tares, which are found invaluable by those breeders who use them for a start. Lambs should never be placed upon rested summer-eaten clover pastures, however tempting they may appear, as they invariably cause scouring, fever, and other severe ailments. Old grass, clover, or grass-eddish is preferable until the autumn quarter commences, which is considered an important one, as much depends upon the manner in which the lambs are started, or taught to eat their winter food.

In the middle of September the lambs are placed in moderate lots upon grass or seeds, as, from the domestic habits peculiar to the race, they are fond of picking their food at this season of the year, cabbages being thrown to them upon the pastures, or cut for them in troughs: after a short time a few white turnips are mixed with them, as a preparation for the winter. As October advances they are placed upon the common or white turnips. Some breeders mix a little coleseed in the first sowing, which is an excellent plan. After a short time the wether-lambs are given $\frac{1}{4}$ lb. of oil-cake, or corn to that value, each per day; at Christmas they are placed upon the swedes which are cut for them, as are also the white ones upon bad layer. As the spring advances, the oil-cake or corn is increased according to circumstances, whether intended at once for the butcher, or to be kept until Midsummer, or even later. The ewe-hogs are kept entirely upon turnips and cut clover-chaff, with plenty of salt. When the turnips are finished, the ewe-hogs are placed upon moderate grass-land or old seeds. When the wether-lambs are reserved for fat shearlings, they are placed upon the young clovers to commence their work, and are sold by some breeders about August or September, to make room for the lambs. Other breeders prefer to keep fewer ewes, and keep their shearlings on until the following spring, when they are again shorn and sold to the butchers in the neighbourhood, being too heavy for the London trade. In this case the lambs are never separated at an early age, but are kept together until 14 months old.

In many parts of Leicestershire the lambs are wintered upon grass only, and are frequently sold fat as early as the following August and September: some breeders keep them over until the next spring or midsummer. It is the practice with some to draft their ewes at the age of three years or three shears, and place them with a horned Dorset or Southdown ram, for the purpose of feeding what is termed "lamb and dam." In this case the ewes are usually sold in high condition at the Leicester

October fair, and are much sought after by different breeders from the adjoining counties. At this fair a considerable trade is carried on in the sale and letting of rams, it being the conclusion of the season; but the leading breeders prefer *letting* their sheep at home, which commences on the 8th of June, and continues during the season.

The *Southdowns* are a breed of animals distinct from every other race, and are best adapted to the warm heathy soils of the southern counties. They are classed under the head of "the Sussex, Hampshire, and Norfolk Downs." The *parent* and principal stock are indigenous to the county of Sussex, where they have long existed, but they were first improved and brought into general notice by the late Mr. John Ellman of Glynde, who, like the celebrated Robert Bakewell, suceeded in establishing his peculiar views in breeding, and to whom this country will ever be much indebted. Previously to his efforts the breed was little known in England (except in their own localities, such as the South Downs of Sussex, whence they derive their name), and was left to chance or the management of shepherds, with whom it could not be a matter of interest to *sort* or improve, more attention being paid to numbers for going to fold than to improvement in their form and quality. They were not taken to market before three years old, when they were designated "the old Downs," and were much sought after as possessing fine texture of flesh, and well suited to the table of the epicure. A liberal price was paid per lb., but this in reality amounted to a small sum per head, owing to their inferior weight. The decided and popular results of the late Mr. Ellman's enterprise drew the attention of other breeders to the importance of improvement: his males were eagerly engaged, and since that period they have been propagated by the different breeders upon Bakewell's principle with immense success; their character has been improved and their fleece and form increased. From the increased importance of our manufactures, and the growing taste for finer descriptions of woollens, as well as the preference given for fine-grained mutton, they now fairly rank amongst the most valuable breeds, and are becoming both a profitable and fashionable race. They are propagated with success in many parts of England, particularly among noblemen and gentlemen, who cultivate them alike for their quality of mutton and general park-like appearance. On many farms the rams are used for the purpose of crossing with the long-woolled breeds. The more popular flocks are those of his Grace the Duke of Richmond, Mr. Ellman, and Mr. Jonas Webb, the latter having in fact created a new and beautiful style of animal, peculiar to his ideas, which may be justly termed the "Babraham flock" of Southdowns.

The *Hampshire Downs* were originally very large and coarse, but of late years they have been improved by an admixture of the Sussex Down; still, however, they retain an extra degree of size, bone, and fleece to any other, and are easily distinguished by those characteristics. Breeders who prefer strong sheep consider this variety better than any other for enduring hardship and for general purposes.

The *Norfolk Downs* were distinguished from the others by their dark or black faces; they were found chiefly in Norfolk and Suffolk, where folding was much practised; but, by the introduction of the Sussex Down by the late Earl of Leicester, the Norfolk Downs have been in a great degree supplanted. His lordship took considerable interest in exposing them by the test of experiments with the Sussex. The few that remain are found upon the borders of Norfolk and Suffolk; the *old* Norfolks are also nearly extinct.

The Sussex breeders, in setting their flocks, adopt the universal plan of selecting those ewes which possess the established "Southdown" qualities of colour, uniformity of character, lightness of offals, thick of lean flesh, and propensity to fatten, with beautiful fine wool. The Hampshire breeders prefer and select a much stronger cast of animal throughout. Many breeders who followed in the footsteps of the late Mr. Ellman, having noticed the result of his experience in remodelling the animal, and increased propensity to fatten, carried these views too far, and the animal was becoming too refined; but subsequently attention has been paid to the essentials of size and constitution, from which much good has resulted. The early management of these flocks up to, and during, the lambing season is very similar to that of the Leicester breeders; the principal difference is in their favour, they being more hardy during lambing-time, and less loss is experienced amongst the lambs: the circumstance of these sheep being raised specially for the downs, heaths, and thin arable soils in the southern counties attached a degree of importance to their after-management, they being more or less dependent upon the scanty produce of the downs, unless provision be made to supply other food throughout the year. In these situations they are sent regularly to fold, with the exception of those put out for fattening. It was originally the plan to keep the wether sheep with the general flock, and allow them to go to fold until drafted for the London market; more recently they have been divided, and fed at a much earlier age,—many are fatted at the age of sixteen or eighteen months. With some breeders, who have good meadows and other advantages, the ewes and lambs are not allowed to go to fold, their system being to force their lambs forward for the September fairs, when they fetch exceedingly high prices; others

under less favourable circumstances send them to fold regularly, and sell their lambs in a lean state at the same period, that being the season at which the great transfer between the breeders and feeders takes place. Of late years they have also found their way into the more distant counties to be fatted upon the turnip-soils. The ewe trade has also materially increased, they being sought after for the purpose of crossing with the Leicester or Long-Wools; they are then included with the general flock, rarely or never being sent to fold, and make great improvement. When mixed with other breeds, they are found to produce more lambs, and give more support to them, but produce less value of wool and consume more food, which is shown by the following experiment:—On the 1st of November, 1830, 100 Down ewes were placed on the one side of a turnip-field of 7 acres, and 100 Leicester ewes on the other; they were each allowed all they chose to eat: on their meeting, the land was measured on both sides, when the Down ewes were found to have eaten a trifle more than 4 acres out of the 7, the crop being an even one, and the ewes penned across the lands. The subject of folding is peculiar to this breed of sheep. This practice was one of the general objects and amongst the earliest pursuits of our ancient flock-masters, who, from the open state of our island, the absence of artificial manures, and the national importance attached to the flocks, looked upon it as the leading feature of the then pastoral age; but by the rapid strides in the application of artificial manures, the old system is fast going out of fashion, it being now rarely practised, except by compulsion upon the downs and heaths, where it is considered better to fold on the land than allow the sheep to roam at large. In the general practice of folding for the purpose of manuring the land for wheat, or otherwise, it is found by repeated calculations that the deterioration of the animals exceeds the return in the shape of manure (when compared with the present price and easy access of the new artificial manures), as the disturbance of the animal, transferring the choice of their hours of feeding and rest from themselves to the shepherd, and their being kept in large flocks, each affect their domestic habit and constitution: the only true feature is the transfer of the produce of the grass-land to the arable, whereby the breeder may reap the benefit of both. In situations where folding is compulsory, it is far better to have prepared sheep-yards, regularly littered with straw or stubble, where they would raise a large quantity of manure, rest warm and comfortable, and be supplied with cut clover, chaff, hay, or vegetables, than to fold them thickly upon a bleak situation, or more particularly when they are placed a second night in the same unwholesome fold, which is usual when a "good dressing" is

required. The strongest advocates for folding are the "Hill-side" farmers, who state it to be better for the sheep to deposit manure in those situations than by carting—an endless task. Would it not, in such situations, be better to lay them down to "sheep-walk," or use artificial manure?

Many breeders in the Southdown districts and southern counties adopt the system of fattening a part of their lambs for the London market. In this case those ewes that are intended to produce lambs are drafted from the general flock the year previous, and put with the ram at an early period. The management of lambs from their birth is allowed by all breeders to be the most difficult task in sheep-husbandry; it is regulated throughout by the period or age at which the breeder intends to realize. When they are intended for the *earliest* markets, some breeders adopt the plan of producing what is termed "house-lamb." For this purpose they invariably procure the Dorset ewes, which have been previously put to the ram for the purpose of dropping their lambs at Michaelmas. After the usual preparations for the lambing season, and the lambs begin to come, they are (after a few days) separated from the ewes and placed in a suitably prepared house, or large barn, well littered with straw; the ewes are taken to them three times a-day, but are not allowed to remain beyond the time required for suckling, as the extra heat occasioned by their presence for a longer period would have the effect of producing an uneven and consequently unhealthy temperature—a point to be avoided if possible, as upon the lamb-house being kept at one regular degree of heat depends the more certain and quick composition of animal food, by an union of the elements of the milk, food, and oxygen consumed. The ewes when turned from their lambs are kept as near home as convenient, and supplied with a liberal quantity of turnips, cabbage, coleseed, or other succulent food within reach at this season of the year, together with grains, broken corn, or linseed. Chalk is supplied to the lambs in troughs, both in lump and powder, to prevent looseness—particular attention being paid to cleanliness and a free circulation of air. When the business of drawing them for the London market has commenced, it is not uncommon to suckle the next run of lambs upon the ewes that have had their lambs taken off (in addition to their own dams) which is done by the shepherd holding the ewe a proper time, otherwise the ewes are turned away and made fat. If young, they are sometimes kept on for another season, and sent to fold. The lambs while fatting are also regularly supplied with sweet clover, split peas, broken corn, or bran; in short, it being an artificial production, both the lamb and dam, for the time, are given anything they will eat. When they are intended for the next stage or run, many breeders provide well-littered yards, with covered

sheds all round them: these lambs are always kept in like the "house-lamb."

The front of the sheds are fenced with "lamb-trays," which have upright bars at a sufficient distance to admit of the lambs passing between them, the shed being entirely reserved for their use, and they easily pass in and out when the ewes are brought up for suckling; the only difference in their management being, that these ewes remain in the yard all night. The next run are usually kept up in the lambing-yard for a week, to gather strength; they are then taken with their dams to the turnip-field during the day, and brought back to the yards at night for about a week; after which they are allowed to remain on the turnip-land with the ewes. By the use of the "lamb-trays," the lambs are allowed to run over the unstocked turnips, and have their corn given them outside the trays, apart from the ewes, which have clover-chaff; thence they are removed to the young clover, until drawn for the butcher. The late or grass-fed lambs are produced in the midland counties with common treatment, but of course do not fetch near the price; but as their cost of production is moderate, a question arises whether they do not make as good a return for the food consumed as the more early ones.

The *Long-Wools* are principally classed under the head of Lincolns, New Oxfords, Cotswolds, Teeswaters, and Kents. The long-woolled Lincolns were formerly the chief or only variety produced in the county: they seemed formed for the then rich marshy soils or cold situations (there being little or no heath-land under cultivation), and their principal property was their long, strong wool to protect them against the vicissitudes of the eastern winds upon their bleak open pastures during the winter-months. They were further known by their large white heads and ears, long thin carcase, with exceedingly large bone; and, from their wool-bearing propensity, they were scarcely ever fattened previously to the third year. In consequence of the rapid advances of our manufactures in the production of finer woollens, and the altered tastes of the people, this breed of animals has happily gone nearly out of fashion; some few are yet to be found in the neighbourhood of Louth, Caistor, and Boston, and are sought after by some breeders, who sell their lamb-hogs in the spring to the marsh graziers, to be by them fattened—*if possible.*

With the new era of improvement, when the heaths, wolds, and rabbit-warrens were converted by the spirited breeders into tillage, arose the great importance of adapting the large unwieldy Lincolns (hitherto produced for the rich marshes) to the more moderate production of the heathy soils under improvement; consequently rapid advances have been made in their improvement by judicious crosses with the Leicesters; and at the present time

they rank amongst the most valuable breeds for the purposes assigned to them, and are shown in great perfection at the Lincoln, Caistor, Boston, &c., great spring fairs, at each of which full 20,000 lamb-hogs usually change hands, from the heath and wold breeders to the graziers and dealers from the surrounding grazing districts. But they are principally shown in condition for the butcher; and, instead of representing the old coarse breed, to be fattened when two or three years old, they now combine to a great extent the properties of the Leicester, upon a larger scale, with a longer and heavier staple of wool; in this they have been much aided by the judicious selection of males, from time to time, by the spirited ram-breeders in the different districts in the county, amongst whom I may mention Mr. Clarke, of Canwick, near Lincoln; Mr. Kirkham, of Hagnaby, near Boston; Mr. Dawson, of Withcall, near Louth; Mr. Brice, of Risby House; Mr. Richardson, of Northlands, near Barton-upon-Humber; Mr. Thomas Casswell, of Pointon House; and Mr. G. Casswell, of Laughton, near Falkingham. The mode of feeding and fattening the store-flocks depends entirely upon the soil and situation in which they are kept. No breed of sheep vary more in their character and management, from the circumstance of their being bred to *suit* the marsh-land or arable districts. The flocks suited to the former districts are most commonly bred in the north and north-eastern parts of the county, and possess more the character of the old style of Lincolns. The breeders of this description of sheep make it their study, in setting their flocks, to select those females that possess the longest wool, strong bone, and largest size, their leading object being to raise a thick-fleshed, hardy animal, suitable to their soil and climate, which, from its coldness during the spring months, is only considered suitable for lambs coming rather late in the season. Their plan of management during the lambing season varies but slightly from the Leiceister, with the exception of their having good grass reserved to place them upon after lambing. The lambs are allowed to remain with the ewes until the 1st of August: they are then placed upon clover eddish, and subsequently upon coleseed, and finish with cut swedes. Corn is rarely given in this district; the study of the breeders is to turn out large long-woolled lamb-hogs for the purpose of grazing, when (unless sold to the graziers) they are run very thickly upon their clovers, or middle descriptions of grass-land, during the summer.

From the bleakness of the district, they are not shorn until the beginning of July; and, as these breeders and graziers look more to quantity than quality of wool, it suits their system.

During the month of August they are thinned out to other parts of the farm; they are afterwards placed in their winter-

quarters on the best grass-land for fattening. When they are intended to be sold in March or April, they are allowed from half a pint to a pint of old beans per day, that kind of food being best in their cold situations; on the rich or warmer lands they attain a sufficient degree of fatness without any artificial food, and are also sold off about May. With the graziers they are replaced with lamb-hogs at the late fairs, which is an excellent arrangement.

Those shearlings that have been kept back upon the second-rate grass-lands are put forward amongst the beasts on their rich pastures during the summer; thence they go to coleseed, and subsequently they are sold to the butchers in the neighbourhood, being far too heavy for the London trade, as at this period of the year they weigh from 30 to 36 lbs. per quarter upon an average.

The sheep bred upon the heath and in the middle of the county are the "improved Lincolns" (before mentioned), and their management is closely assimilated to the Leicester, particularly upon the heaths near Lincoln. With the addition of their spirited husbandry in supplying them with artificial food throughout the year, the universal plan of these breeders is to sell their lamb-hogs in the spring from turnips; consequently every movement is brought to bear upon the production of first-rate fat lamb-hogs, whereby an immense return is made in the shape of wool and mutton, as also in the succeeding crops of barley, seeds, and wheat. The effect of sheep-husbandry on the productiveness of the soil is an important feature in the general rules laid down upon the heath-farms; for, as the soil requires artificial aid, so does the importance of producing sheep at an early age become essential. By constant attention to an equal and proper distribution of the flock fed upon artificial food, immense results follow, it being better to spend a portion of the money set aside for artificial manure in the purchase of oil-cake, &c., to be passed through an animal to the soil, thereby gaining a second return, than to expend the whole amount in the production of vegetables.

Again, such are the propensities of the best sheep to fatten, that an ample return of wool and mutton is made for the extra keeping allowed them, and the land is manured at a cheap and easy rate. Further, by the use of artificial food, the vegetable produce is much economized, the animal is kept longer upon the land, and becomes more healthy and less liable to disease.

This result I fully proved by an experiment in the year 1836. On the 26th of October part of a field of Swedish turnips was measured off, amounting to eight acres, and 80 wether-lambs and 80 ewe-lambs were placed upon them in separate pens, the wether-lambs commencing on one side and the ewe-lambs on the other.

Each lot was penned across the lands, so that there might be no difference in the crop or after-management.

The wether-lambs were allowed half a pound of oil-cake each per day during the winter; the ewe-lambs were kept entirely upon turnips; each lot had the turnips cut for them; and when the roots were all consumed, and the lambs met, the land was again measured, and the ewe-lambs were found to have eaten 4 acres 0 rood 32 perches of turnips; the wether-lambs 3 acres 3 roods 8 perches,—thus showing a gain of 1 rood 24 perches of turnips by the use of the artificial food, and longer duration upon the land. The field had been highly manured upon the ridge system for the turnip-crop, which by a calculation (after weighing 22 square yards in an average part of the field) was estimated at 22½ tons per acre.

When the lamb-hogs were placed upon the turnips, 10 average lambs of each lot were weighed and marked, and again weighed every month during the time they remained upon the turnips, which proved to be 16 weeks 2 days. Having no opportunity of weighing the turnips daily to the respective lots, a calculation was made, and it showed the ewe-lambs to have eaten, upon an average, 22½ lbs., and the wether-lambs 20¾ lbs. of turnips each per day. The average gain of the 10 ewe-lambs during the time proved to be 28½ lbs., and the 10 wether-lambs 36¾ lbs. each. The 8 acres were sown with chevalier barley and mixed clover-seeds in the spring, and each part harvested and thrashed separately. They were found to produce—the 4 acres 0 rood 32 perches, 25 quarters 1 bushel, or nearly 6 quarters per acre; the 3 acres 3 roods 8 perches, 25 quarters 6½ bushels, or 6 quarters 6½ bushels per acre. The young seeds upon the latter, up to the following May, looked weaker than the other; but this I attribute to the heavy crop of barley. The whole piece was grazed during the summer, when the part fed off with the wether-lambs recovered, and was by far the strongest and best crop. The following March the land was sown with Friesland oats, but which were not thrashed separately, the apparent result being so decidedly in favour of the part eaten off by the wether-lambs.

The breeders upon the heaths, from their peculiar situation, plough everything; they rarely or ever occupy any grass-land except in some few instances: they procure a portion of marsh-land, which is situated at a distance, and they then require it most for the purpose of growing, or feeding their cattle raised upon the ploughed farm. In setting their flocks at Michaelmas, their object is to select those ewes which possess uniformity of size, frame, fleece, and style. For producing large, well-proportioned animals, they are also particular in having a long kind head and

ears, as they consider it most essential to the *finish* of a first-rate lamb-hog, and are frequently known to reject a well-proportioned male animal, unless possessing what is termed "good looks." The management of the flock during the lambing season is similar to that of the Leicesters, except that in some instances, in the more southern part of the county, mangel-wurtzel is used, and with success, as is shown by the following correspondence with a leading breeder:—"When I formerly depended upon turnips for my inlambed ewes, my loss was frequently very *great:* since using mangel-wurtzel during the lambing season, out of 500 ewes I do not recollect ever losing more than three from the effects of lambing. The succulent nature of the root, and the large proportion of saccharine matter it contains, gives it a great advantage over any other vegetable in the production of milk, so essential to the breeding ewes in suckling their lambs in the early part of the spring."*

The principal breeders on the heath and wolds have a great fancy to put forward their wether-lambs from the earliest period; they are separated from the ewe-lambs, and take precedence. When taken off about the middle of July, they are still supplied with corn or oil-cake upon the seeds, and thence they are placed upon the turnips, cabbages being little used in this district, the artificial food being continued. As the barley-thrashing advances, they give them bruised barley and malt-comb with their oil-cake; which it is to be regretted cannot be supplied to them in the shape of malt, containing more saccharine matter. If malt-comb be good for sheep (the mere shadow, or husk), what must the substance itself be? As the spring advances, the artificial food is increased with the cut swedes. The "hilling," or getting up, of the Swedish turnips at the close of the year is becoming a general plan. The feeding qualities of the root are thereby preserved, the land is not drawn by running up, and the vegetables are more easy of access during the winter months. When this plan is adopted, a portion is removed to the field intended for turnips the following year, to be consumed at the latest period of the season, that the turnip-land may be set free early for sowing with barley and young seeds. When swedes are allowed to remain on the land until they are daily pulled for the sheep, they get

* After trying mangold for four successive years, I came to the conclusion that cows fed on it gave quite as much milk, but *much less* butter and cream, than when fed on turnips or carrots: also, that when ewes were fed on mangold-wurtzel the lambs throve remarkably ill, which I attributed to the same poverty of milk which had been proved in the case of the cows. The kind was the orange-globe; the roots large, and perfectly sound; were not used till after Christmas, and were grown on land of rather weak staple, but what is termed hereabouts "good sand land."—H. S. Thompson.

dry, and are inferior in quality towards the end of the season; the sheep become tired of them, and are very restless; but in every instance where the turnips have been "hilled," they are found to do exceedingly well to the last day. Some breeders prefer keeping their lamb-hogs until the late fairs, and allow them to take the best of their young seeds; others reserve them entire for the ewes that are suckling the couples and wether-lambs. In some instances the lambs are not castrated until the first week in August, to produce extra size and constitution, when they are either castrated, or what is termed "traped," and are rarely known to falter or decline eating their food after the operation.

The ewe-lambs are drafted early in the winter, and the culls placed with the wether-lambs to be sold in the spring,—the best being reserved for the flock, and kept entirely upon turnips. The flock-ewes are inspected and drafted early in the summer, and are removed from their lambs about the first week in June, when they are prepared for the autumn fairs, and fetch high prices, breeders from the surrounding districts being anxious to procure them. In the southern or Grantham district, the wether-lambs are kept upon moderate food during the winter, it being the practice to sell them as shearlings in the autumn, when they are purchased by the graziers for wintering upon their grass-land, or for feeding off coleseed, where the land is intended to be sown with wheat, which is a growing practice.

The *New Oxfords* are termed long-wools, but more from the circumstance of their not coming under the denomination of Leicesters than from their extra wool-bearing properties. They are bred principally in Oxfordshire and the surrounding districts, particularly in the neighbourhood of Broadwell, the residence of Mr. Charles Large; Charlbury, the residence of Mr. Smith; and Sevenhampton, the residence of Mr. Handy,—the most eminent breeders, and to whom great credit is due for their exertions in raising this valuable breed to its present high state of perfection. They are of large dimensions, and have a great propensity to fatten, arising chiefly from their wide frame, quietude, and open texture of flesh, which is of quick growth, and consequently expands itself more rapidly than many other qualities; but they do not possess that exactness of form peculiar to smaller animals, though they have a better carriage. For many years the male animals have been eagerly sought after, with a view to increase the size and frame of other long-woolled breeds.

The *Cotswolds* are a breed chiefly found in the same district of country as the New Oxfords, but more particularly upon the Cotswold hills, in Gloucestershire, whence they derive their names; they are also frequently called "Gloucesters." Their general properties so nearly resemble the New Oxfords, with the

exception of the slight deviation of their flesh, which is not so firm or fine in its texture, that it is unnecessary to repeat them. This breed of sheep has also shared in the fashion of the age, and has been alike sought after of late years, particularly the flocks in the neighbourhood of North Leach, the residence of Mr. Hewer, one of the leading breeders; they have also been purchased for the purpose of crossing with the short-woolled breeds, and to good effect.

The two breeds, being so nearly allied, may be treated under the same head of management; they are alike confined to the hills and surrounding arable districts, the soil of which is more or less of a thin character, and consequently requires good sheep husbandry, which is practised to some extent. It is a leading feature with the breeders to produce their sheep at an early age, and folding is rarely practised by the best flock-masters in this district of country.

In setting the flocks particular attention is paid to size, wool, strength of constitution, propensity to fatten, and uniformity of character and carriage, by which the animals are easily distinguished from other long-woolled breeds. The ewes are placed with the ram rather early in the season, and care is taken to have a reserve of fresh keep to remove them to about the middle of September. The rams are continued with the ewes about nine weeks—the latter part of the time they are kept upon white turnips, as the hill soils produce but moderate keeping at this season of the year; thence they are drawn out weekly upon the plan adopted by the Leicester breeders. Great attention is paid to their flocks during lambing-time, their yards being made very warm and comfortable. The wether-lambs are put forward and managed upon a similar plan to those upon Lincoln Heath; but these breeders are more particular in having early spring feed for them. They are supplied with corn, according to circumstances, through the summer. When the clovers are going off about Midsummer they are frequently removed to green tares provided for them, the ewes being taken away and placed in some distant field. When the lambs are placed upon the tares, they are either allowed fresh pens from time to time, as they require them, or the tares are mown and given them in racks, or laid alongside the trays, to be eaten through them. The better plan, when consumed upon the land, is to have a regular set of *iron trays,* upon feet, coupled together by rings and staples. These trays should be 12 feet long, upon oak feet $2\frac{1}{2}$ feet long, which may be moved in an onward direction several times a-day, according to the consumption through them. By this plan the tares are much economized, and fed off without being the least soiled. These "iron trays," being portable, are equally good for

feeding off coleseed upon the same principle, and are much used for this purpose in South Lincolnshire, where it is not uncommon to see coleseed much higher than the sheep, particularly in those situations where "paring and burning" is practised, and the seed drilled in with a portion of bones. The feeding properties of *this* coleseed are unrivalled by any artificial food.

When the feeding of tares is practised to any extent, they are sown at different intervals during the spring, to hold out until after harvest, at which time the lambs are removed to the barley stubbles, or young seeds, and are supplied with white turnips thrown upon the land for a short time. They are placed upon the turnips at the end of September, and commence their winter management with cut turnips and artificial food, which is increased during the winter. About March and April they are sold fat to the butchers in the neighbourhood, or sent to the London market. Those breeders who bestow less care and expense upon their lamb-hogs sell them in a store state at the principal fairs in the neighbourhood, to be fattened by the graziers: the breeders, in fact, make it their practice to clear them off when the turnips are finished. The flock-ewes are drafted and sold upon the plan adopted by the Lincoln-Heath breeders.

Under the head of long wools the old *Teeswaters* may be mentioned, although the kind is nearly extinct. The animals were originally bred more particularly upon the banks of the Tees, in Yorkshire, whence they derive their name, and in those days were thought valuable for that district of country, as they possessed great size and constitution (similar to the Lincolns), and were bred from the same stock. By the breeders paying more attention to size than to wool, they became a different style of sheep; but subsequently, by crossing with the Leicesters, they have become more in conformity with the Yorkshire description, and cannot now be traced to any particular locality. The sheep of the Yorkshire class is a bold upstanding animal, with gay looks, open wool, and open texture of flesh. The Yorkshire breeders prefer selling their produce as shearlings in the autumn: they make a great display at the Market Weighton Fair, on the 25th of September. Their management is very similar to that observed on Lincoln Heath—those animals fattened from turnips being forced during the winter, and those intended for shearlings are kept more moderate, and placed in the early part of the summer upon the clovers, whence they are removed to early coleseed, sown expressly for finishing them off, in which they very much excel.

When the shearlings are sold, the wether-lambs are placed upon the coleseed, to clean up previously to their going to turnips and the land being sown with wheat: this is considered the best

arrangement for finishing the shearlings, starting their lambs, and preparation for the succeeding wheat-crop.

The *Kents* are principally confined to the county whence they derive their name, but are mostly bred and grazed in Romney Marsh; they were originally a coarse description of animal. A prejudice in their favour still exists with some breeders, although they acknowledge to have received a benefit in crossing with the Leicesters. The principal feature in their management is the entire change the animals undergo, from being bred upon the marsh-lands and sent (about September) to winter upon the uplands or turnip-soils. They are taken back to the marshy districts about the beginning of April for the summer, when, the land being exceedingly luxuriant, they are placed very thickly upon it, and remain so during the early part of the summer; they are afterwards thinned out to other pastures, for the purpose of fattening, which process is completed by the end of the season. The ewes are placed upon the grass-lands for the winter until lambing-time, which commences later than in most other counties, the breeders making no extra provision for them, preferring, in fact, to turn their ewes and lambs at once into their grass-pastures.

The breeds I have hitherto mentioned comprise the long-wools, adapted to the richest grass-lands and marshes, which yield produce suitable for the finest worsted manufactures; the Leicesters, for less fertile soils and enclosed arable land (on which the fold is not used), intended to supply a staple of wool for the manufacture of coarse cloths, blankets, carpets, and worsted stockings; and the fine short-woolled breeds, as the Southdowns, for arable lands, heaths, and sheep-walks on which folding is practised, for producing a staple of wool suitable for the manufacture of cloths of middle qualities. In addition to these there is a hardy race for our mountain and northern districts, such as the Scotch and Cheviot breeds, which, from their uniformity of character, have become, as it were, indigenous to the locality in which they are found. On the lower hills at the extremity of the Cheviot range they have been frequently crossed with the Leicesters, of which several flocks, originally Cheviot, now possess a great share of their form and fleece; many have been sent to the highlands of Scotland, where they have succeeded pretty well, but are not found so hardy as the heath or black-faced kind.

Diseases.

No department in our sheep husbandry is so little understood, even by practical men, as the various diseases among sheep. It would be a tedious and unprofitable task to enumerate all the

minor affections, but it is highly requisite to notice those which come more closely under our daily practice, such as the foot-rot, (or foot-halt) diarrhœa, dysentery, scab, rot, sturdy, blind, red-water, sore heads, and fly-galls.

The *Foot-rot* is a disease most common on old grass-land or marshy situations, and most prevalent in wet seasons: it clearly shows that an extra degree of moisture is injurious to the hoof, and that, by being softened or relaxed beyond the habit of the animal, a fretful disposition is produced. It commences between the claws, and ultimately forms a matter which spreads itself so rapidly that, if allowed its course and not checked, it completely undermines the hoof, and occasionally throws it off. So soon as the disease makes its appearance in a lot of sheep, they should be immediately had up and placed under cover, the shed being well littered, to clean their feet; the whole of their feet should then be examined, observing to rub in a small portion of the halt ointment (afterwards named) between their claws, to dry up the accumulating matter, or to act as a preventive with the sound feet. They should remain in the shed until the following morning, and then be placed in a short pasture, or upon stubble-ground. If the disease be found to have advanced, the hoof should be carefully removed to the bottom of the disease, as the dressing will cure just so far as it is applied. In fact, if one single particle of the matter remain untouched, it will continue its ravages—hence arises the apparent difficulty in staying its progress.

When the foot has become much diseased from neglect, it should be placed in an oil-cake poultice for 12 hours; then washed clean with warm water, and the poultice renewed again 12 hours more; then to be again washed, and the diseased parts probed to the bottom and dressed; then to be tied up in common tar for 24 hours, and renewed when necessary, again applying the ointment. Opening medicine will materially assist in the cure of obstinate cases. The worst subjects should be regularly removed from the general flock as they occur, the disease being certainly infectious; it is, besides, more convenient for dressing and shutting them up—a course that is highly essential, in order that the feet may be kept clean and dry for a time after the ointment has been applied, which I have found invaluable both in staying its progress and curing the disease.

The Halt Receipt.

1 oz. corrosive sublimate, 1 oz. blue vitriol, 1 oz. spirits of salts, 1 oz. verdigris, 1 oz. horse turpentine, 1 oz. oil of vitriol, ¾ oz. spirits of turpentine, and 4 oz. sheep ointment.

[To be well mixed when prepared, and kept tied down when not in use.]

Diarrhœa is most known amongst lambs after weaning, when

they have been incautiously placed upon luxuriant keeping. The young succulent grasses are most likely to produce it, or a sudden transition from heat to cold, producing weak bowels, will cause it. When the disease is observed to be coming on, the animals should be instantly changed to older or dry keeping. If the disease has advanced unnoticed, they should be taken up, kept warm, supplied with dry food, and given 1 oz. of castor-oil, in half a pint of gruel; if the animal has much pain or straining, add 20 drops of laudanum, with rather more gruel; if the discharge still continues, and the bowels have been cleared by this dose, it will be proper to check it by astringents. The following is found to be an excellent medicine, and rarely fails:—

4 oz. logwood, 1 drachm of the extract of catechu, and 2 drachms of cinnamon, mixed with 3 pints of water, boiled for a quarter of an hour; strain it off, then add 60 drops of laudanum. Give half a pint night and morning as long as the flux continues.

Dysentery.—Although some breeders class this disease with the diarrhœa, I consider it to be very different,* being found most amongst the older sheep during the summer months, particularly in hot, sultry weather, or when they have been run too thick upon short pastures, and are consequently more easily acted upon. It is distinguished by the frequent discharges of slimy or green matter; further on in the disease they are mixed with blood; the belly is drawn up, the appetite lost, the animal wastes rapidly, and the disease proves fatal very quickly, unless it be arrested by powerful medicine and warm treatment. The approach of death is known by the black scour coming on, which is an aggravation of the disease, being mixed with shreds of dark gangrene matter from the decomposition of the intestines. If the disease has only just commenced, bleeding is highly necessary; but if advanced, great caution should be observed, and the pulse attended to, to avoid lowering the system too much. To effect a cure a reaction, or perfect change in the system, is necessary, and may be best produced by exciting the action of the skin. To effect this the animal should be immersed in a tub of hot water for 15 minutes, then given 1 ounce of castor-oil, with 30 drops of laudanum, in a little gruel, taking care that the animal be kept warm by wrapping, and placed in a warm shed. As the animal recovers, give gruel freely, with a more moderate dose of the above; when the appetite returns, give mixed food, such as hay and vegetables.

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* Diarrhœa and dysentery are undoubtedly different complaints, and one great distinction between them is, that an attack of dysentery is dangerous *from the commencement*; but diarrhœa is only serious when accompanied by dysentery, which it usually is after continuing for any length of time: and I believe diarrhœa seldom proves fatal to sheep until dysentery comes on.—H. S. Thompson.

During this disease care should be taken not to pull the wool, as it frequently falls off: a change of pasture, and not run too thick, is the best preventive. I have also found either of the following receipts to stay its ravages when given in time: they may be adopted, when parties reject the hot-water plan, with equal success:—

No. 1.

4 Tablespoonfuls of common salt,
1 Teaspoonful of turpentine,
Mixed with a little water, and repeated in a milder dose when necessary.

No. 2.

1 Teaspoonful of laudanum,
1 Tablespoonful of either gin or rum,
Well mixed and given; repeat the dose if necessary, or in a milder form.

No. 3.

1 ounce of alum in half a pint of warm water.

The above three receipts will also stay the progress of the diarrhœa in lambs.

The Scab.—This is a disease familiar to all breeders—to some from the dread they have of it, and to others from its constant plague. In the open fields the flocks were formerly rarely ever without it from their constant intermixture, and it is a fact that the open-field shepherds were careless in staying its progress, from the feeling that they always have it in the field. It is known to exist by the animals becoming restless, with a constant desire for rubbing; when the disease has become rooted, the animal itches to such a degree that it is quite violent in pulling its wool &c. When taken in the early stage of the complaint, little specks are noticed, which are found to contain a minute insect burrowing in the skin; then by rubbing the skin becomes fretted, discharging an ichor, which hardens into crusts, and if the sheep be not relieved it sinks under the accumulated miseries. This disease is exceedingly infectious, but is never observed or known to arise spontaneously in a flock. When first discovered the whole flock should be carefully inspected, and the diseased subjects removed to a separate field; it is best to give the whole flock a slight dressing, as a preventive; no fear need be entertained in dressing the inlambed ewes, as I have had occasion to practise it at different periods, and have experienced no ill effects, observing not to dress the belly or points. The mercurial ointment in common use, prepared by all druggists, is found to be sufficiently good, without resorting to other receipts: when ordered, the party should take care to name that it is required for

the specific purpose of curing the disease, that attention may be especially paid to the grinding of the quicksilver. In mild cases one dressing by an experienced shepherd, at the rate of 3lbs. to the score for full-grown sheep, and $2\frac{1}{2}$ lbs. for younger ones, will prove sufficient, plenty of shreds being the principal feature, and also observing to dress the points pretty freely; care should be taken to shut them up for one or more nights according to the case, and afterwards kept in a warmer situation, if possible, for a time, and given a good supply of food. In bad cases it is proper to inspect them weekly, until the disease be entirely removed, and give opening medicine pretty freely. Should any die under the operation, the remainder should be washed immediately; if the disease do not then stop they should be shorn, which is a certain remedy.

The Rot.—It is beyond my power to give an accurate account of this disease, as scarcely two breeders agree as to its origin. By some it is thought that the animal takes up the larvæ of some grub, deposited on swampy or wet situations, which find their way to the vessels of the liver, and are there reared up and become flukes, which absorb the chief nourishment of the blood of the animal; hence the white veiny appearance, and the deficiency of blood and general decline. Others think that the disease is produced by bad health or management at some particular period, which becomes habitual. When observed coming on, the animals should have dry meat, with a plentiful supply of salt to lick, placed in small iron troughs: they take it freely. The following simple receipt, given for three or four mornings *fasting,* has proved of great value, and is the best (out of the many) I have met with:—$1\frac{1}{2}$ ounce of common salt, with three-fourths of a pint of water, well mixed before use. In one experiment, a sheep being killed one week after this dose had been given, 120 flukes were taken out of its liver, most of which were dead. In support of this, it is well known that sheep never have flukes when pastured upon the salt-marshes.

Sturdy.—This affection may be the result either of pressure upon the brain, from an animal growth, or from the accumulation of a fluid, the excess of which leads to the dilatation of the skull and to the absorption of its walls, when the bones can no longer be made to yield; for this reason the skull, towards the termination of the disease, generally becomes thin and soft, and offers a spot easily detected, and from its being easily pierced is frequently made the seat of surgical operations; but they are rarely known to succeed.

The sheep has a dull stupid look, turns round, and frequently falls. This disease by some breeders is said to be hereditary, and often produced by close breeding; but as it rarely occurs in sheep

more than 18 months old, and having experienced it in the produce from a first cross, I attach but little importance to this opinion, but think it more likely to arise from the malformation or growth of the animal's head, it not being known to occur after the animal has done growing.

The Blind.—This disease makes its appearance amongst the young sheep more particularly, but it is hard to tell how they acquire it; the animal sinks rapidly under its progress, unless it be arrested at an early stage, which may be done by an application of common tar, rubbed round the outside of the eye, to be repeated in about four or five days, when they will recover their former energies.

Red-Water is known most upon turnip-soils, during the time the animals are feeding them off; an accumulation of this water takes place, and cannot be passed off without aid, which may be accomplished by the following receipt, when taken in time:—1 oz. of common salt, $\frac{1}{4}$ pint of water, and $\frac{1}{2}$ a tablespoonful of turpentine, well mixed in quantity for the number, and freely shaken when used.

The best preventive is a constant supply of salt, either given in chaff, or rock-salt placed in troughs to be licked at leisure.

Sore Heads and Fly-galls.—These are troublesome complaints, which are much better avoided than cured. In woodland situations *capping* at an early period is decidedly the best plan, but it should not be done later than the 1st of June or when the sheep are shorn; then by attention to keep the caps on their heads, very little annoyance will be experienced; but *never* place a cap upon a *sore* head. When this plan is not adopted, the heads and flanks of the whole flock should be dressed with a mixture or preparation of the dregs of whale-oil and brimstone, sufficiently thick for use, to be applied with a round brush from a suitable tin or pot. My practice is to clip the flock early, and then dip them at once with Bigg's composition, before they are affected with the flies, and apply the preparation to their heads, which is repeated every fortnight to the heads and flanks during the fly-time; they are kept by this plan perfectly clean. When fly-galls have commenced, a small quantity of spirits of tar may be mixed with the brimstone and whale-oil and applied to the parts. When they are very bad, a plaster of the following preparation will be found useful:—Horse turpentine, tar, and wheat-flour, well mixed together.

Having endeavoured so far to comply with the Society's instructions contained under the head of "The Management of Sheep," I proceed to give *the result of my own practice.*

Before what is termed "setting a flock" in any locality, due regard should be paid to the soil, situation, and climate on which they are to be produced, as that *alone* should govern the decision

as to what breed or description of animals should be propagated to produce the largest return. Having decided upon the variety of sheep, care should be taken to select the *best* of that particular breed, as in every breed much choice is open to decision; this principle should be strictly observed in the selection of females, but more particularly in the choice of males, by no means being influenced by over-fed animals, unless they are strictly in conformity with the rules laid down for establishing the flock. In the production of male animals much depends upon the principle laid down; I have practised every plan by way of experiment, but have found none equal to what is termed "breeding in the line." With "crossing" and breeding "in and in" I have been most lamentably disappointed, there being no dependence on the first, and no size to be procured in the latter; even in "breeding in the line," much depends upon the union or knowledge of matching the male and female, particularly if selected from different families, even of the same race, which have been for some time raised in other localities, and consequently influenced by climate, soil, situation, and treatment. When using rams of the same flock, they should by no means be put together nearer than a *third* remove in the same line of blood; I have, by repeated experiments, experienced, by the nearer affinities of blood, the most decided disappointment, but have raised some first-rate animals by putting the third removes together, when attention has been previously paid to the sort required.

From close observation I have found the quality and quantity of wool to be governed by the quality or description of flesh upon the animal; hence certain wool and certain mutton go together: further, so often as the wool is observed to change upon the back or otherwise of the sheep, so does the quality of flesh change, commencing at the exact division of the varieties of wool—thus showing the importance of selecting those animals that possess the best description of wool and mutton. Now these carry but *one* sort of wool upon their frames, and that of a mellow, moderately long, thick, bunchy character, under which is found the mellow flesh peculiar to first-rate animals, which flesh is found to spread or expand itself more rapidly than any other, but with a sufficient degree of firmness. Under short fine wool is found extra firm or hard flesh, which does not expand or grow in proportion. With thin-set, strong wool, we find the animal to have a white objectionable head, with loose or coarse-grained flesh, wanting in quality in due proportion to the wool it bears; and the animal is never, in consequence, known to spread wide, but represents its degree of fatness along the back. In the selection of male animals it is even better to choose a strong animal from a well-bred flock of the same family than to step out of "the line" to

cross with a large sheep of inferior blood, as practice has shown that the produce from a large inferior-looking sheep, selected from a pure-bred flock, has been far better than those produced from an apparently good sheep selected from a cross-bred flock. In matching the animals I have found it desirable that the female should possess the larger frame for supplying an increased support to the improved progeny, particularly when the object is to produce *male* animals: thus it is equally important to keep up the strength of the ewes to afford this advantage, which can alone be done by strict attention to that object, by mixing strong sheep with those ewes that are not termed "ram-breeders," and the well-formed sheep with the others, as the offspring invariably partakes in the proportion of *three-fifths* after the male, again showing the importance of procuring good males of pure descent: hence the Leicesters will correct and assist what are termed the larger breeds; but in no instance have the larger males improved the best Leicesters, and more particularly when the "cross" has been an extreme one, which is frequently shown in a *twin* produce, as they often represent opposite qualities. Again, in reference to the *principle* of breeding, although the Leicesters will improve the larger breeds, we find that, when mixed with smaller breeds, the produce require equal additional support to maintain the increased size; for instance, our mountain breeds may be enlarged by crossing, but the progeny will not prosper on the hilly pastures of their dams, and would be equally unprofitable on the pastures of their sires, but succeed equally well on the intermediate situations, thus clearly showing the importance of *assisting* nature, by suiting the animal to the particular soil, situation, and climate, rather than leaving it to *climatize* or adjust itself to the locality in which it is placed.

Such is the effect of soil and situation, that when animals have been equally divided and kept apart for twelve months, upon opposite soils, they have scarcely resembled each other when placed together again, beyond the family head. It is said by some breeders that a good animal should approach the form of a "soda-water bottle;" but I prefer the upper and under lines to run *parallel* with each other, and extend themselves to the very extremity of the animal's frame, but have no objection to the oval sides. It is important that the sheep should display a degree of *grandeur* in its movements, which can alone be accomplished by a proper formation of the general frame: for instance, when the "soda-water-bottle" form is adopted, the animal has a thin neck, narrow hind quarters, wide sides, or hanging fore flanks, and invariably stands upon short fore legs, consequently it walks with difficulty, and carries its head in a low position; but, on the other hand, when the chines or shoulders are well thrown into

the back, blended with well-sprung top ribs, long hind quarters, the flesh or fat laid even, or in mass throughout the upper form, the animal stands open and well upon the fore legs, and consequently becomes *habitually* gay and easy in its carriage.

The *crossing* of the pure breeds has been a subject of great interest of late amongst every class of breeders. While all agree that the first cross may be attended with good results, there exists a diversity of opinion upon the future movements, or putting the crosses together. Having tried experiments (and I am now pursuing them for confirmation) in every way possible, I do not hesitate to express my opinion, that, by proper and judicious crossing through repeated generations, a most valuable breed of sheep may be raised and established; in support of which I may mention the career of the celebrated Bakewell, who raised a *new* variety from other long-woolled breeds by dint of perseverance and propagation, and which have subsequently corrected all other long-woolled breeds.

Having determined upon a series of experiments for my private information, and being desirous to ascertain the best and most economical plan of producing good animals (and having subsequently confirmed at least the greater part of them), I proceed to give them at full.

Experiment No. 1.

On the 20th of December, 1842, 8 lambs were weighed and placed upon the regular turnip-land (a red loam, with cold subsoil), to consume the turnips where they grew, and were regularly supplied with what cut swedes they would eat, which proved to be on an average 23½ lbs. per day. They were again weighed on the 3rd of April, 1843, being 15 weeks, and found to have gained upon an average, during the time, 25½ lbs. each.

No. 2.

On the same day, 8 lambs were placed in a grass paddock, under the same regulations, and found to have consumed, on an average, 19 lbs. of turnips per day, and gained during the time 26¾ lbs. each.

No. 3.

On the same day, 8 lambs were placed alongside the No. 2 lot in the grass paddock, and allowed to run in and out of an open shed during the day, but regularly shut up at night. They were allowed half a pound of mixed oil-cake and peas each per day, and consumed 20½ lbs. of turnips per day, and gained 33½ lbs. each.

No. 4.

On the same day, 8 lambs were placed with the Nos. 2 and 3 lots in the grass paddock, under the same regulations as No. 3, but supplied with 1 lb. of mixed corn per day. They consumed 20 lbs. of turnips per day during the following 10 weeks, being again weighed on the 28th of February, 1843, and gained on an average 26½ lbs. each.

No. 5.

8 lambs were also placed in a warm paddock, with a shed to run under during the middle of the day, but were shut up at least 18 hours, and fed upon $1\frac{1}{4}$ lb. of mixed corn per day, and consumed $18\frac{1}{2}$ lbs. of turnips per day. They were again weighed at the same time as No. 4, and found to have gained $33\frac{1}{2}$ lbs. each during the 10 weeks.

No. 6.

On the 5th of January, 1843, 16 shearlings were equally divided, and 8 placed upon a grass paddock, and allowed 1 lb. of mixed corn each per day. They consumed 24 lbs. of Swedish turnips each per day. They were again weighed on the 2nd of March, being 8 weeks, and were found to have gained $21\frac{1}{2}$ lbs. each.

No. 7.

On the same day the other 8 shearlings were placed alongside the No. 6, in the grass paddock, and allowed 1 lb. of mixed corn each, and consumed $20\frac{1}{2}$ lbs. of turnips per day. They were allowed an open shed to run under during the day, and regularly shut in at night; and again weighed at the same time as No. 6, and were found to have gained 24 lbs. each during the 8 weeks.

No. 8.

On the 3rd of April, the 8 lambs (No. 3), having been weighed, were placed upon young clover, and supplied with half a pound of mixed corn, as before. They consumed 12 lbs. of turnips per day during the following month. Being again weighed on the 1st of May, they were found to have gained $11\frac{3}{4}$ lbs. each. They had a shed to run under during the day, and were shut up at night.

No. 9.

On the 29th of May the 8 lambs (No. 8) were again weighed, having been allowed, as before, half a pound of mixed corn upon the clover, but no turnips, with a shed to run under at will. They were found to have gained 16 lbs. each during the month.

To prove the temperature of the animal body during the hot weather, I placed the two lots of shearlings, No. 6 and No. 7, upon moderate clover, on the 1st of July, 1843.

No. 10.

The 8 shearlings (No. 6) were weighed, and allowed 1 pint of peas per day, and again weighed at the end of 21 days, and were found to have gained $9\frac{1}{4}$ lbs. each.

No. 11.

The 8 shearlings (No. 7) were also weighed, and given 1 pint of old beans per day, and again weighed at the same time, and were found to have gained 6 lbs. each, the peas appearing most suitable to the animal temperature during the hot weather, and the beans far too hot. What is more important, those sheep fed upon beans were getting full

of humours in this short space of time, while those fed upon peas were looking exceedingly healthy.

In the autumn of 1843, after making the above experiments, I determined upon testing the qualities of the various vegetables open to our use at that season of the year. On the 2nd of October, 1843, 30 lambs were equally divided into lots of 10 each, and placed upon over-eaten seeds. They were all weighed, and the roots regularly given them by an experienced shepherd.

No. 12.

10 lambs, fed upon cut white turnips, were again weighed on the 13th of November, and were found to have gained upon an average 15½ lbs. each.

No. 13.

10 lambs, fed upon cut swedes, gained during the 6 weeks, upon an average, 11 lbs. each.

No. 14.

10 lambs, fed upon cut cabbage, gained during the time 16½ lbs. each, showing, as I fully expected, a preference in favour of cabbage, but, to my equal surprise, a great difference in favour of the white turnip over the swede. By subsequent experiments, I found, as the cold weather advanced, the cabbage and white turnip became of less value, and that the swede improved.

In the autumn of 1844, having placed my ram-lambs in their winter quarters, and observing that those placed upon cole-seed were going on apparently the best, I determined to weigh a part of them in comparison with those placed in pens upon grass-land; consequently, on the 14th of October, 1844, the following lots were weighed, as in previous experiments, the 10 upon the cole-seed being selected from 24 others, marked, and again placed with them.

No. 15.

10 lambs penned upon cole-seed, with cut clover-chaff, were again weighed at the end of 1 month, and found to have gained 12½ lbs. each.

No. 16.

10 lambs penned upon drumhead-cabbage, with cut clover-chaff, and weighed as above: they gained 10½ lbs. each.

No. 17.

10 lambs placed upon grass, and fed upon cut swedes and cabbage, of equal quantities, with clover-chaff, gained 9¾ lbs. each.

No. 18.

10 lambs placed upon grass, and fed upon cut white turnips and cabbage, of equal quantities, with clover-chaff, gained 11 lbs. each.

Having frequently given my lambs carrots during the winter and spring months, and to no apparent advantage, when compared with other roots, I determined to test their qualities after the expiration of the above experiments, and the No. 16 lot were supplied with what swedes they would eat, and the No. 17 lot with carrots.

No. 19.

10 lambs, fed upon cut swedes and clover-chaff, having been weighed at the end of the other experiment, were again weighed on the 9th of December. They were found to have gained during the month 10 lbs. each, and consumed 22 lbs. of turnips each per day.

No. 20.

10 lambs fed upon cut carrots and clover-chaff were weighed as above on the 9th of December, and were found to have gained $9\frac{1}{4}$ lbs. each, and consumed $22\frac{1}{2}$ lbs. of carrots each per day,—

Thus proving that the carrot cannot be given to sheep with equal profit, when compared with the swede turnip, the carrot being more expensive and hazardous in its cultivation, and producing rather less animal food from a given weight at this season of the year.

Thus, by a careful review of these experiments throughout, it will be found that *warmth* is proved to be an important feature in sheep husbandry, and is a subject affecting the rural economy of the whole nation. For instance, taking the average temperature of a sheep's body at 100 degrees, and the average temperature of our climate at 60 degrees, in every respiration of air the animal loses by the *exchange* animal heat equal to 40 degrees, which, if not again supplied by the elements of food, or artificial warmth, the animal would cease to exist. Hence the animal frame becomes a machine for the conversion of vegetable food into animal food, as the animal heat produced by the supply of food is generated by the combustion caused by the union of the oxygen of the external air with the carbon, hydrogen, and other elements of the food: thus, when the temperature of the animal body is below the *standard* of heat,* it requires a proportionate artificial warmth to economize the vegetable food, and assist the fattening propen-

* All our great authorities represent the variation of temperature of the animal body to be confined within very narrow limits indeed. Liebig, in fact, hardly allows it any scope at all. "The most trustworthy observations prove that *in all climates*, in the temperate zones, as well as at the equator or the poles, the temperature of the body in man, and in what are commonly called warm-blooded animals, is *invariably the same.*"—Liebig's Organic Chemistry of Physiology, p. 19. But, whatever be the exact amount of variation of animal temperature, Mr. Smith, as an eminently practical man, will, I am sure, admit, that in practice it would never do to vary the treatment of our flock whenever the thermometer showed a minute alteration in the temperature of their blood, and that the simpler the practical rule can be made which is founded on scientific principles, the more likely it is to be generally acted on. I would suggest, therefore, that instead of endeavouring to "keep the animal body at an even temperature," it would be better simply to recommend flock-masters to keep their stock as warm as they can, consistently with *perfect ventilation*, and that the principal points to pay attention to are—1st, That the cost of the shelter is not such as to absorb the profit arising from its use; and, 2nd, That the health and well-doing of the sheep should decide whether the warmth and confinement are carried too far or not.—H. S. Thompson.

sities of the animal, which are governed materially by the formation of the internal structure or frame; for instance, when the chest is contracted, the animal is restless, and the respirations are more frequent than with the wide, open chest, which is the sure guide to quietude, and consequently *fewer* respirations.

But when the animal body is forced *beyond* its standard of temperature, the result is proportionably unprofitable: the animal laws being impeded, Nature withdraws her support, and the animal body becomes at once artificial, ungovernable, and exposed to every difficulty: the animal frequently sinks under the pressure which has been caused by extreme feeding, or improper ventilation when placed in sheds, as the exhalation of the animal would enter into a state of decay, or unite with the oxygen of the air, and thus be *again* inhaled and conveyed to the lungs and intestines, the seat of all infirmities. Thus, having been supplied with too great a stimulant, in the shape of food, for the amount of oxygen inhaled, the system becomes deranged, and the digestive organs cease to perform their functions; and as the temperature of the body exceeds the standard of heat (see experiment No. 11), so advances the danger of inflammation and apoplexy, which can alone be stayed by cooling medicine, and by the animal being gradually exposed to the free temperature of the air, when, from the additional oxygen received, combined with the exercise and *increased* velocity of its respirations, the animal body is restored to its standard of heat or health. Thus, to keep up the temperature of the animal body for its required purposes, it is necessary to supply food or warmth, according to the temperature of the situation. The principle, therefore, is confined to this: At all times endeavour to keep the animal body at an even temperature, which must be adjusted as the seasons roll on, or as the soil and climate vary in the different localities; for instance, when sheep are kept up in sheds during the winter, and intended to be kept on through the summer, a corresponding temperature must be observed, or the animal machine would cease to perform its fattening evolutions, which is beautifully shown by the increasing fatigue represented by the sheep to support his warm winter coat as the spring months advance, and which nature directs should be cast off at the expiration of its functions. Many breeders have a dread of clipping their sheep early. Experience has taught me to consider the animal first, which dictates the removal of the fleece when the great change of temperature takes place, as the animal loses flesh under the sudden increased pressure of heat. By various experiments carried on through the summer months to test the difference of weight gathered by the different lots of sheep that had been fed in the different degrees of heat during the previous winter, I found that those sheep which had been kept the coolest increased most,

and that those fed in the warmest sheds made but little progress when exposed to the free temperature of the air; thus proving that all animals intended for the butcher should be sold from the sheds. I have since adopted the middle course with rams that were intended to be shown the following September, and have provided a number of boarded trays, for the purpose of supplying them at all seasons of the year with open sheds. The heads of these are made of oak, 6 feet long by 4 inches square, and hooped on the top: the frame or tray is 9 feet long, and boarded with feather-edged board 4 feet deep, leaving about 20 inches to be placed in the ground. Four of these trays, two at the back and one at each end, make an excellent open shed for 8 or 10 sheep (according to their size) to run under. These trays are placed open to the south during the winter, and, being portable, are removed with the sheep to the clover or tares for the summer, when they are reversed, to keep out the heat, but regularly littered with clean straw or stubble; this the sheep enjoy, and they are induced by it to remain under cover during the heat of the day. When placed upon clover, a constant supply of green tares, in racks, during the heat of summer, is very desirable to cool the system, or reduce the pressure of heat upon the animal body, that the process of fattening may be carried on with greater success, as on an even temperature of heat depends the composition of animal food, and the consequent return for the vegetable food consumed.

Thus, after many anxious reflections upon the *principle* which "science" had dictated, "practice" has shown it to be one of great magnitude, and to develop the mysteries of past ages, by pointing out those elements of the vegetable creation best adapted to Nature's laws, under the varied temperature of the seasons. Experiments serve to elucidate and confirm this; but as the result of the experiments goes to show the *average* amount of animal food produced from a given quantity of vegetable food under the different degrees of "warmth," I am bound to add (and this is truly important), that the different animals in many instances varied considerably in their gain; consequently, while the experiments confirm that a proper degree of "warmth is an equivalent to food," I found, by close observation, they also confirmed that the form and sort of animal invariably governed the *difference* in the production or composition of animal food referred to.

Hence the importance of breeding and feeding robust, *docile*, symmetrical animals, to produce the largest return for the quantity and quality of food consumed.

Burley-on-the-Hill, Rutland.

II.—*Account of Hall Farm, near Sevenoaks, Kent, for Eight Years, from March* 25, 1838, *to March* 25, 1846.

To Lord Amherst.

Alvechurch, near Bromsgrove, May 9, 1846.

My Lord,—I have great pleasure in submitting to your consideration the following account relative to Hall Farm, and the more so, as I consider it a remarkable instance of what can be accomplished by the judicious application of skill and capital. The character of the farm, consisting as it does to a considerable extent of a very inferior soil, and part of it a perfect sand-bed, is too well known to your Lordship, and to all those in its immediate neighbourhood, to require any comment from me; but it will be well, before I proceed to the more practicable part of the business, to give a short history of the farm for some time before it came under the excellent management of your present bailiff, Mr. Robert Jones.

Hall Farm is free of corn-tithes, and contains 250 acres, 3 roods, and 2 poles, and is divided as follows: arable, 190 acres, 5 poles; pasture, 40 acres, 2 roods, 37 poles; hop-ground, 20 acres. The buildings are complete for the occupation of the farm and hop-grounds, and have always been kept in repair by the landlord. Previous to the year 1827, the farm had been for a long time in hand; and by reference to the accounts it will be clearly seen that during that period a great loss was annually sustained. In the year 1827 it was let upon lease for fourteen years, at a rent of 200*l.*, but the tenant, after holding it for six or seven years, requested permission to give up his lease, upon the ground of his losing at least 300*l.* per annum by it; and although the farm was offered him for the remainder of his lease at the reduced rent of 100*l.*, he still urged his request for permission to give up his holding immediately, expressing a fear, that if compelled to occupy the farm till the termination of his lease, he should sink the remainder of his capital. He was allowed to give up his lease, and in 1835 the farm was again taken in hand. From 1835 to 1838, the farm being under very indifferent management, and no foundation laid for future profit, the result was as in previous cases, a great loss, amounting in the two years of 1835 and 1836 to 973*l.* 0*s.* 10*d.*, and in the year 1837 to no less than 602*l.* 1*s.* 8*d.*

In the spring of 1838 Mr. Robert Jones took the management of the farm, and I will now proceed to show the state in which he found it, and the means pursued by him to better its condition.

The state of it was such that it was found necessary to summer-fallow nearly the whole of the land for two years in succession;

and it is a fact, that from many of the fields no less than 200 cart-loads of couch were carried off per acre. The land was frequently ploughed, no less than six or seven times in the year, and in order to do this the 2-horse ploughs were substituted for the heavy and cumbersome Kentish plough generally used in that part of the country. A better rotation of crops was introduced when the land became thoroughly clean, and the miserable system of cross-cropping, or taking two or more white straw crops in succession, was altogether abolished. Great care has also been taken to provide sufficient shelter for the stock, by which means they fatten faster and upon less food. Tanks have also been provided for collecting liquid manure.

Owing to the greater part of the farm being naturally dry, very little draining has been required, but that little has been effected by the following rather ingenious method: wells have been sunk to the depth of from 20 to 30 feet, at which distance from the surface the Kentish rag, as it is called, or stone, is usually found. These wells receive the water from the different drains which empty into them, and as the Kentish rag is of great extent and thickness, and very porous, the wells are capable of receiving any quantity of water which may issue from the drains. Part of Knole Park has been drained upon the same principle, and could have been drained in no other way without a very great expense, as from the formation of the surface much difficulty would have been found in obtaining a fall. The wells are arched over at top, or filled up with stones, so that a stranger walking over the farm would not be aware that any draining had been accomplished.

The system of cropping introduced generally, taking a field of 20 acres as an instance, is as follows:—

1st	year	20	acres of	turnips.
2nd	,,	20	,,	barley.
3rd	,,	20	,,	seeds, generally mown once.
4th	,,	20	,,	wheat.
5th	,,	10	,,	rape.
,,	,,	10	,,	winter tares for summer keep.
6th	,,	20	,,	oats, barley, or peas, &c.

Under this system, one half the land is in green crop; and the result has been, that the quantity of produce of every kind has been nearly doubled; and the stock, which consisted in 1838 of 10 horses, 14 cows, 222 sheep, and 14 pigs, in 1845 consisted of 10 horses, 12 heifers, 444 sheep, and 10 pigs, exclusive of 300 sheep which in 1841 were added to the farm from Knole Park.

Previous to the year 1841, the sheep in Knole Park were kept distinct from those on the farm; but in that year Mr. Jones stated that it would be an advantage if the two flocks were treated

as one. This was allowed, with the understanding that, during the time the sheep or any part of them were in the park, the farm should be charged with an agistment price of 3*d.* per head per week. By reference to the account it will be seen that the flock now consists of 744 sheep, a most enormous flock, I admit, for a farm of this extent. The privilege of turning the flock into the park, although a great advantage to the farm, is not, however, so beneficial as at first sight may appear; for the whole of the flock has been kept upon the farm during the winter months; and in 1841, 1842, 1843, and 1844, the agistment amounted to about 45*l.* only, equal to 300 sheep for twelve weeks, at 3*d.* per week each; and in 1845 the agistment amounted to 60*l.*, equal to 300 sheep for sixteen weeks at the same rate. It is well known that the herbage of a park where a large herd of deer is kept, as in this instance, is not very beneficial to other stock; and this remark is fully borne out by the circumstance, that the sheep are entirely fattened on the farm, and that previously to 1841 it was customary to purchase Welsh and Southdown sheep for the sole purpose of eating the coarse grass left by the deer. I consider the advantage derived to the farm from the park scarcely equal to what would be obtained from a good sheep-walk, which many Southdown farms possess, and where it is usual to fold sheep on the arable land from the sheep-walk, which is *not* done at Hall Farm. The privilege of turning stock into the park was always allowed upon the same terms when the tenant required it.

A reference to the account will show that the main dependence of a farm of this description must be upon stock; indeed, it is impossible to keep a soil of this character in good heart and condition without it, or without incurring an expense which will effectually prevent any profit from being derived from its cultivation. During the five years from 1838 to 1842, the sums received for sheep amounted to only 1565*l.* 13*s.* 6*d.*, while at the same time the sums paid for sheep purchased amounted to 679*l.* 14*s.*, leaving a balance in favour of the farm of 885*l.* 19*s.* 6*d.* only, or 177*l.* 3*s.* 11*d.* per annum. From 1843 to 1845, inclusive, the sums received for sheep amounted to 1311*l.* 13*s.* 3*d.*, while during the same period the money expended in the purchase of stock amounted only to 44*l.* 8*s.*, leaving a balance in favour of the farm of 1267*l.* 5*s.* 3*d.*, or 422*l.* 8*s.* 5*d.* per annum. The difference in the returns of the two periods arises from the circumstance of a breeding-flock having been gradually substituted for a dry one; and I trust there will be no occasion to purchase much stock in future. The price of stock at the present period may be alluded to as in great measure accounting for the profit of the farm; but in answer to this I must remark, that the present profit is not much greater than the loss sustained during

the prevalence of the disease amongst the sheep a few years ago. Great care has been taken in the selection of the flock, and also in the management of it, as the price of the sheep now unsold (and which are certainly not over estimated) will fully show.

The following statement may give some idea of the management of the flock: in the first week of August, 1845, the flock consisted of about—

300	full-mouthed ewes, selected for lambing the following spring.
250	ewes and wethers, from $1\frac{1}{2}$ to $2\frac{1}{2}$ years old.
300	lambs of the spring of 1845.
100	old sheep fatting.
950	

Such of the lambs of the spring of 1845, and some of the ewes and wethers from $1\frac{1}{2}$ to $2\frac{1}{2}$ years old, which are not wanted to keep up the flock, are sold or fattened, and by that means the flock is reduced, before the lambing-season of the following year, to about 750. They are generally fattened on the farm.

In the autumn of 1846, such of the 300 ewes as were selected in August, 1845, but which have since become broken-mouthed, will be put aside, and either sold or fattened, and their places supplied by younger ones.

I now approach a subject upon which there perhaps exists a greater difference of opinion than upon any other thing connected with agriculture; and that is the amount of capital required for the cultivation of a farm of this size and quality; for while 4*l.* or 5*l.* per acre is considered by some as sufficient for the purpose, others contend that at least 10*l.* or 12*l.* will be required. I do not think, under ordinary circumstances, that 10*l.* per acre will be found more than sufficient, and in the present instance I conceive that the following estimate will be found a pretty correct one. On entering a farm the tenant should calculate upon being twelve months without any return, and provide accordingly.

The stock on the farm, in the spring of 1838, consisted of and were valued as follows:—

	£.	*s.*	*d.*	£.	*s.*	*d.*
10 Horses, at 25*l.* each	250	0	0			
4 Milking cows	36	0	0			
1 Calf	2	0	0			
10 Barren cows	65	0	0			
2 Sows	5	0	0			
11 Store pigs	6	12	0			
1 Boar	2	0	0			
77 Ewes, at 30*s.*	115	10	0			
143 Wethers, at 30*s.*	211	10	0			
2 Rams	3	0	0			
Carried forward	£696	12	0			

Brought forward . . .	£696	12	0			
The inventory, including tillages, manure, implements of husbandry, &c. amounted to	972	2	7			
				1668	14	7
To this should be added for ploughing and sowing the spring and turnip crops, taxes, and other expenses incurred before any return can be expected from the farm, at least				300	0	0
Add one year's maintenance for the tenant and his family, say	200	0	0			
One year's rent	150	0	0			
				350	0	0
				£2318	14	7

—the capital which a tenant should have on entering a farm of 230 acres, 3 roods, 2 poles; or 190 acres, 5 poles, arable, and 40 acres, 2 roods, 37 poles, pasture,—being very nearly 10*l.* per acre.

From further reference to the account it will be seen that during the first seven years the receipts, after deducting the payments, were not sufficient to pay the rent and provide for the tenant's living, and consequently a further sum had to be annually advanced for that purpose:—

	£.	*s.*	*d.*		£.	*s.*	*d.*
In 1838 the receipts amounted to	935	9	1	And the payments to . .	971	2	7
Sum required to balance at Lady-day, 1839 . .	352	9	6	Add one year's rent . .	150	0	0
				One year's tenant's living, or interest on 1668*l.* 14*s.* 7*d.*, the sum paid for tillages, stock, &c. in 1838, at 10 per cent.	166	16	0
	£1287	18	7		£1287	18	7

To Lady-day,	1839, the sum required as above was .			352	9	6
,,	1840,	,,	,,	286	8	0
,,	1841,	,,	,,	183	4	9
,,	1842,	,,	,,	470	1	10
,,	1843,	,,	,,	498	11	7
,,	1844,	,,	,,	217	2	10
,,	1845,	,,	,,	140	19	4
	Total			2148	17	10

Interest should be allowed upon these sums from the time they were advanced to the spring of 1846, at the same rate as upon the rest of the capital employed in the farm; but as the rent is not usually paid till the end of the year, and the tenant's maintenance is not paid all at once, I have allowed interest from the spring of 1839 only.

The farm account is as follows:—

Farm Receipts.

	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Average of 8 Years.
	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Sheep	386 18 6	181 8 6	263 7 0	513 1 4	220 18 2½	344 12 5	358 9 8	608 11 2½	359 13 4
Pigs	34 6 0	43 0 0	43 19 1	34 19 4	46 0 11½	54 11 3½	70 17 6	59 2 2	48 7 0
Cattle	62 7 0	156 19 0	113 0 8	6 15 0	16 0 0	33 0 0	47 8 4	8 10 0	55 9 1
Wheat	230 6 0	293 17 9	283 12 10½	240 17 0	265 18 6	366 14 6	215 13 9	499 9 7½	299 11 3
Barley	104 0 0	58 14 6	147 18 9	180 6 10½	178 14 3	75 4 0	180 18 3	203 2 0	141 2 4
Wool	38 4 6	41 5 0	48 10 0	50 14 9	106 7 6	83 12 0	105 0 0	100 18 9	71 16 7
Carrots	20 18 6	30 0 0	..	..	..	..	..	..	6 7 4
Potatoes	3 10 6	..	6 9 0	61 2 6	25 8 6	36 19 6	46 11 1	57 2 0	29 12 10
Incidents	31 18 1	..	..	.	..	..	..	..	3 19 9
Poultry	..	7 12 6	..	5 19 9	..	17 19 4	..	30 6 6	7 14 9
Stones	..	15 0 0	44 14 0	..	..	..	..	..	7 9 3
Milk	..	6 5 0	7 10 0	7 10 0	7 10 0	7 10 0	..	..	4 10 7
Oats	..	..	2 12 6	..	..	..	..	..	0 6 6
Turnips	..	..	..	2 10 0	1 2 6	..	1 5 0	..	0 12 2
Underwood	..	..	..	..	..	..	22 6 0	..	2 15 9
Team-work employed in the Hop Gardens	23 0 0	23 0 0	23 0 0	23 0 0	23 0 0	23 0 0	23 0 0	23 0 0	23 0 0
Totals . . . £	935 9 1	857 2 3	984 13 10½	1,126 16 6½	891 0 5	1,043 3 0½	1,071 9 6	1,590 2 3	1,062 9 4

FARM PAYMENTS.

	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Average of 8 Years.
	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£ s. d.	£. s. d.	£. s. d.
Beer	25 0 0	14 6 0	15 0 0	15 0 0	15 0 0	13 5 0	13 5 0	13 5 0	15 10 1½
Labour, allowed at the rate of 12*s.* per week, with beer at hay-time and harvest	247 1 10	332 2 1	326 12 6½	304 1 7½	367 14 11¾	393 10 5	323 9 0	343 15 6½	329 16 0
Fencing	10 7 7	3 10 6	16 3 7½	14 15 6	40 16 2¼	3 18 8	32 10 5	17 12 7	17 9 4½
Rates	46 9 2	57 6 4	44 2 11	51 19 6	63 2 4	57 13 2	52 0 11	51 5 9½	53 0 0
Manure	124 16 9	65 6 0	173 19 2	165 19 3	119 9 1	163 11 8½	182 3 2½	163 18 4¼	144 17 11
Seed	51 8 6	30 15 6	49 6 0	97 10 0	52 14 0	52 19 3	66 7 2	89 9 10	61 6 3½
Oil-cake	43 10 6	41 0 0	57 17 6	130 0 0	45 6 0	41 14 0	9 0 0	37 0 0	50 13 6
Implements	19 3 5	22 11 11	25 1 5	25 6 0	52 10 7	34 16 6	32 4 6	22 1 11	29 4 6¾
Blacksmith	40 6 5½	45 19 8	49 18 11½	45 8 3½	72 5 3½	51 3 5	49 1 0¾	65 0 5½	52 7 11
Saddler	12 1 9½	11 17 10	14 3 0	15 11 5	15 13 5	19 19 7½	17 19 10	21 15 2	16 2 9
Farrier	4 10 6	0 19 6	7 11 5	18 8 0	1 19 1	14 0 0	10 4 6	4 11 2	7 15 6
Destroying Vermin	6 15 0	6 15 0	6 15 0	6 15 0	10 2 6	3 7 6	6 15 0	6 15 0	6 15 0
Insurance	1 0 0	1 11 6	1 10 0	1 10 0	..	1 10 0	2 5 0	2 5 0	1 8 11
Stationer	0 12 11	1 10 1	1 8 8	1 12 8	2 1 8	1 1 10	1 13 1	1 1 3	1 7 9
Barley-meal, Bran, &c.	20 4 3	20 10 7	22 0 8	23 2 10	29 17 2	15 17 5	11 17 7	11 10 9	19 7 8
Incidents	4 0 0	17 14 9	..	4 0 5½	..	10 8 6¾	8 5 3	6 13 4½	6 7 9¾
Tithes	20 16 10	19 10 2	11 17 5½	13 4 5½	12 18 0	11 18 11	12 4 0	12 4 0	14 6 9
Wheelwright	18 13 1	10 10 11	7 3 0	1 12 4	11 7 1	4 6 3	5 7 4	16 8 6	9 8 8
Sheep purchased	215 9 0	108 1 0	..	265 0 0	91 4 0	..	..	44 8 0	90 10 3
Cattle ditto	58 15 0	13 6 0	13 13 0	..	..	..	24 0 0	72 0 0	22 14 3
Daining	..	1 8 11	6 18 3	..	10 13 8	3 7 8	..	3 19 0	3 6 7
Hores purchased	..	..	..	27 0 0	..	..	..	17 0 0	5 10 0
Cabbage-plants	..	..	..	8 10 0	..	..	..	..	1 1 3
Agisiment	..	..	..	43 15 0	45 0 0	45 0 0	45 0 0	60 0 0	29 16 10½
Corn for sheep	..	..	..	..	12 16 0	..	..	..	1 12 0
Totals . . . £	971 2 7	826 14 3	851 2 7	1,280 2 4	1,072 16 0¾	943 9 10¾	905 12 10	1,084 0 8½	991 17 7¾

N.B. The amount paid for oil-cake may appear to many persons as very trifling; but a very considerable portion of the corn grown upon the farm was each year given to the sheep, and not charged to the account or entered in the farm receipts.

Summary of Farm Account for Eight Years, to Lady-day, 1846.

Dr.

	£.	s.	d.	£.	s.	d.
Amount received in 1838	935	9	1			
,, ,, 1839	857	2	3			
,, ,, 1840	984	13	10½			
,, ,, 1841	1126	16	6½			
,, ,, 1842	891	0	5			
,, ,, 1843	1043	3	0½			
,, ,, 1844	1071	9	6			
,, ,, 1845	1590	2	3			
				8499	16	11½
Stock unsold at Lady-day, 1846 :—						
9 Cart-horses, at 28*l.* each	252	0	0			
1 Ditto	6	0	0			
12 Heifers	72	0	0			
2 Sows	5	0	0			
1 Ditto	3	0	0			
1 Boar	2	10	0			
6 Store Pigs	6	0	0			
317 Ewes in Lamb, at 34*s.*	538	18	0			
118 Tegs, at 30*s.*	177	0	0			
108 Wethers, at 34*s.*	183	12	0			
106 Ditto, at 38*s.*	201	8	0			
8 Rams, at 30*s.*	12	0	0			
50 Wethers, at 55*s.*	137	10	0			
37 Ewes, at 36*s.*	66	12	0			
				1663	10	0
Carried forward			£	10,163	6	11½

Cr.

	£.	s.	d.	£.	s.	d.
Amount paid for Stock in 1838, viz. :—						
10 Horses, at 25*l.* each	250	0	0			
4 Milking Cows	36	0	0			
1 Calf	2	0	0			
10 Barren Cows	65	0	0			
2 Sows	5	0	0			
11 Store Pigs	6	12	0			
1 Boar	2	0	0			
77 Ewes, at 30*s.*	115	10	0			
143 Wethers, at 30*s.*	211	10	0			
2 Rams	3	0	0			
	696	12	0			
Amount paid for Tillages, Manure, &c.	972	2	7			
				1668	14	7
Amount paid in 1838	971	2	7			
,, 1839	826	14	3			
,, 1840	851	2	7			
,, 1841	1280	2	4			
,, 1842	1072	16	0¾			
,, 1843	943	9	10¾			
,, 1844	905	12	10			
,, 1845	1084	0	8¼			
				7935	1	2¾
Carried forward			£	9603	15	9¾

Dr.

	£.	s.	d.	£.	s.	d.
Brought forward	.	.		10,163	6	$11\frac{1}{2}$
Corn unsold:—						
173 quarters of Barley, at 30*s*. .	259	10	0			
120 ditto of Wheat, at 50*s*. . .	300	0	0			
16 ditto of Oats, at 25*s*. . .	20	0	0			
				579	10	0
Amount of Inventory at Lady-day, 1846, viz., Tillages, Implements of Husbandry, Manure, &c. . . .	.	.		2043	9	0
Balance due from the Farm . .	.	.		257	2	$10\frac{1}{4}$
Total . . .			£	13,043	8	$9\frac{3}{4}$

Cr.

	£.	s.	d.	£.	s.	d.
Brought forward	.	.		9603	15	$9\frac{3}{4}$
Eight years' rent to Lady-day, 1846, at 150*l*. per annum	.	.		1200	0	0
Eight years' interest on 1668*l*. 14*s*. 7*d*., the capital employed, exclusive of rent and tenant's living, at 10 per cent. .	.	.		1334	8	0
Seven years' interest to Lady-day, 1846, on 352*l*. 9*s*. 6*d*., the sum advanced towards rent, &c., to balance the account (see p. 5) at Lady-day, 1839, at 10 per cent.	246	15	0			
Six ditto to ditto on 286*l*. 8*s*. 0*d*., advanced Lady-day, 1840 . . .	171	16	6			
Five ditto to ditto on 183*l*. 4*s*. 9*d*., advanced Lady-day, 1841 . . .	91	12	6			
Four ditto to ditto on 470*l*. 1*s*. 10*d*., advanced Lady-day, 1842 . . .	188	0	0			
Three ditto to ditto on 498*l*. 11*s*. 7*d*., advanced Lady-day, 1843 . . .	149	11	0			
Two ditto to ditto on 217*l*. 2*s*. 10*d*., advanced Lady-day, 1844 . . .	43	8	0			
One ditto to ditto on 140*l*. 19*s*. 4*d*., advanced Lady-day, 1845 . . .	14	2	0			
				905	5	0
Total . . .			£	13,043	8	$9\frac{3}{4}$

N.B.—Mr. Cronk, who made out the inventory, states, that in addition to the tillages, &c., valued according to the custom of the county of Kent, a further sum of 300*l.* should be allowed for the improved condition of the farm since 1838. I have not brought this into the account, as I consider it doubtful how far a tenant could be found to pay that sum in addition to the inventory, which amounts to 2043*l.* 9*s.* Had I done so, the balance would have been 42*l.* 17*s.* 2*d.* in favour of the farm, after allowing 10 per cent. on the capital invested.

To those who are unacquainted with the *inventory system* which prevails in Kent and Sussex, and some other parts of the country, the foregoing account may appear rather difficult to comprehend; but as it is not possible to make it out in any other shape, I trust the following explanation may in some measure obviate that difficulty. The amount of the inventory (2043*l.* 9*s.*) includes all the ploughings and other preparation for the crops of 1846 which had been made by the offgoing tenant previous to Lady-day, 1846; it also includes the implements, manures on the farm, hay and straw on the premises, at a foddering price, turnips unconsumed at Lady-day, 1846, and many other little matters. The incoming tenant ploughs and sows the land for the spring and turnip crops, and takes the whole of the produce of 1846. The difference between the amount of the inventory paid in the spring of 1838 and of that paid in 1846 is no less than 1071*l.* 6*s.* 5*d.*, and arises principally from the additional value of the implements, and also from there being a much greater quantity of hay and straw and manure on the farm at the latter period. The inventory system is most objectionable in many respects, as the incoming tenant is too often called upon to pay for acts of husbandry which have been most inefficiently performed; but still the evil cannot be got rid of unless the landowners will take upon themselves to pay the amount of these inventories. If they were to do so they might fairly charge an additional rent for the land, as much less capital would be required to enter upon a farm than is now the case.

From a careful perusal of the foregoing account, we find that in taking a farm naturally so sterile and out of condition as this was in 1838, a capital of not less than 1668*l.* 14*s.* 7*d.*, or 7*l.* per acre, was requisite in the first instance, and that in this case a further sum of 2148*l.* 17*s.* 10*d.* was required over and above the proceeds of the farm to pay the rent and provide a maintenance for the tenant; so that in fact the capital invested in the farm in the spring of 1846 was as follows:—

	£	*s.*	*d.*
Inventory paid for in 1838	1668	14	7
Further amount required to pay rent, and towards tenant's living, &c.	2148	17	10
Total amount invested .	£3817	12	5

or about 16*l.* per acre. We also find that where a sufficient security exists, the most stubborn and unproductive soil, if naturally dry, may

by the application of great skill and capital be made to produce such a return as will fully justify the expenditure of that capital; and we further find, that where a farm is thoroughly out of condition it is in vain to look for a speedy return; but, on the contrary, that many years must elapse, and those probably attended with much care and anxiety, before it can be even hoped for.

Before I close my remarks, I feel bound in justice to Mr. Robert Jones to state, that it will be difficult, if not impossible, to meet with a farm under better management than the one now under consideration, and I would earnestly invite the attention of all those who are interested in the success of agriculture to it. A journey of a few miles will be well repaid by the opportunity they will have of witnessing a triumph of skill over obstacles of no ordinary nature; and although they may return from the inspection of this farm without any desire to undertake the cultivation of one similar to it, I feel assured they will admit, that if success has been met with in this instance, there is no reason to fear the result where they have a more genial soil to deal with, and where the same means are applied as in the case before us.

Hop-Ground.

In the case of the hop-gardens it is not necessary for me to trouble your Lordship with many remarks. I believe that if the hop-grounds in Kent and Sussex were kept distinct from the other part of the farm, as they ought to be, and all manures, hop-poles, &c., were charged to the hop-account, as in this instance, the hop-cultivation would not be so much esteemed as it now is. There is, however, considerable benefit derived indirectly from the cultivation of hops, and it consists in the great employment it affords to the poor, not only in the hop-gardens themselves, but also in the woods, which are very extensive in the Wealds of Kent and Sussex, and are very valuable from the growth of hop-poles. The following account exhibits a profit, for the eight years, of 1140*l.*, or about 22 per cent. upon the capital employed; certainly not more than ought to be calculated upon, considering that the cultivation of hops must be regarded in the light of a speculation:

Hop Receipts.

	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Average of 8 Years.
	£. s. d.	£. s. d.	£. s. d	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Hop Receipts . . .	662 0 0	792 13 0	161 0 0	1,415 3 0	1,263 6 9	756 11 0	1,122 9 5	559 2 3	841 10 8

Hop Payments.

	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Average of 8 Years.
	£. s. d.	£. s. d.	£. s. d	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Labour at sundries . .	69 0 6½	67 7 3	46 13 7½	45 5 1½	60 14 9¾	35 8 8½	44 15 3¼	40 14 4	51 4 11½
Manure	102 12 4½	143 3 11	95 13 1	105 16 8	155 4 1	62 5 2	136 17 4	28 5 9	103 14 9½
Hop-poles	112 4 6	184 1 2	54 17 1	146 3 1	164 8 6	130 1 10½	161 17 7	67 11 10	127 11 11½
Digging	21 18 9	26 14 5	20 12 8½	22 3 4	22 5 1	37 10 9	21 1 6½	20 3 11½	24 1 3½
Poling Hops . . .	20 0 10¾	22 11 1½	17 2 0	18 15 8½	18 13 7½	14 19 9½	17 2 7	18 9 6	18 9 4½
Duty	92 15 10	147 6 3	194 18 6	13 7 0¼	141 3 0¼	215 11 2	92 11 2	136 19 9¾	129 6 7
Fuel	13 7 0	20 14 0	5 16 6	16 9 8	18 15 0	9 12 0	13 0 9	8 16 0	13 6 3
Picking	81 12 1	145 19 9½	23 1 8	113 14 6	139 18 3	61 3 1¾	77 5 3½	67 11 11½	88 15 10
Drying	17 8 0	22 11 0	5 10 4	15 16 0	21 19 3	9 5 0	18 1 9	14 13 9	15 13 1½
Tying	12 3 8½	12 3 9½	12 0 6½	9 10 3½	10 1 11½	11 0 3½	10 2 4¼	11 1 10	11 0 7¾
Incidents	4 6 11	..	..	..	..	..	..	..	0 10 10½
Pockets	31 15 2½	35 1 5½	7 6 2	31 18 10½	36 10 11½	23 19 10¼	22 1 5	23 8 7	26 10 3½
Tithes	18 0 0	19 11 6	14 16 0	15 2 0	16 16 6	14 1 0	15 6 2	16 4 11	16 4 9
Rates	8 0 0	10 0 0	9 0 0	11 0 0	14 0 0	14 0 0	12 10 0	12 10 0	11 7 6
Hop-cutting . . .	7 6 3½	10 7 2	7 17 2	9 9 3½	8 11 8	7 1 1	5 7 4	5 0 0	7 12 6
Beer	..	12 10 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	9 1 3
Hoeing	20 0 0	26 11 4	18 18 2	34 16 10	20 13 10	20 11 2	25 19 6	11 13 6	22 8 0½
Hop-sets	..	..	2 7 6	..	..	..	..	..	0 5 11
Team-work from the Farm .	23 0 0	23 0 0	23 0 0	23 0 0	23 0 0	23 0 0	23 0 0	23 0 0	23 0 0
Totals . . .	655 12 1¼	929 14 2	569 11 0½	642 8 5	882 16 6¼	699 11 0	707 0 1	515 15 8¾	700 5 11¼

Summary of Hop Account.

Dr.

	£.	s.	d.	£.	s.	d.
Received in 1838	662	0	0			
" 1839	792	13	0			
" 1840	161	0	0			
" 1841	1415	3	0			
" 1842	1263	6	9			
" 1843	756	11	0			
" 1844	1122	9	5			
" 1845	559	2	3			
				6732	5	5
Hop-ground Inventory at Lady-day, 1846, viz. Hop-poles, Tillages, &c.	..			415	7	6
			£	7147	12	11

Cr.

	£.	s.	d.	£.	s.	d.
Paid for Hop-poles in 1838	..			165	1	7
Paid in 1838	655	12	$1\frac{1}{4}$			
" 1839	929	14	2			
" 1840	569	11	$0\frac{1}{2}$			
" 1841	642	8	5			
" 1842	882	16	$6\frac{1}{2}$			
" 1843	699	11	0			
" 1844	707	0	1			
" 1845	515	15	$8\frac{3}{4}$			
				5602	9	1
Eight years' rent of 20 acres, at 30*s.* per acre, to Lady-day, 1846	..			240	0	0
Balance towards interest of capital, or 142*l.* 10*s.* 3*d.* per annum, being nearly 22 per cent. on a capital of 650*l.*	..			1140	2	3
			£	7147	12	11

The capital necessary for the cultivation of a Hop-Garden in Kent cannot be less than the following:—

	£.	s.	d.	£.	s.	d.	£.	s.	d.
Hop-poles, 10*l.* per acre, for 20 acres				..			200	0	0
Other expenses as per average of eight years—see dissected account				700	5	11			
Deduct the duty	129	6	7						
Deduct Hop-poles	127	11	11						
				256	18	6			
							443	7	5
Rent of 20 acres, at 30*s.*				..			30	0	0
							£673	7	5

Averaging, exclusive of duty and interest on Hop-kilns, &c., 32*l.* 10*s.* per acre.

In conclusion, I have only further to observe, that I called in the assistance of Mr. Cronk, and directed him to make out the inventory; and I did so because he is well known in the neighbourhood of Sevenoaks, and is much employed in valuations of this kind, and is moreover a disinterested person. His instructions were to make out the inventory, upon the supposition that the farm would be given up at Lady-day, 1846. Mr. Jones's salary for managing the farm is included in the interest allowed upon the capital employed in the cultivation. Hoping, therefore, that the account may prove satisfactory to your Lordship, I beg to subscribe myself

Your most obedient servant,

James Tomson.

To the Right Hon. Earl Amherst.

III.—*Burning of Land for Manure.* By Thomas Rowlandson.

Prize Essay.

Few subjects connected with agriculture have elicited such opposite opinions as that of burning land for manure; one party advocating the practice as all that is excellent, the other maintaining that it is utterly destructive of future fertility for the sole benefit of the immediately succeeding crop. On a little consideration it will appear that the practice really has its advantages or disadvantages according to the nature of the soil on which the operation is practised: now that it is admitted by all who are in the slightest degree acquainted with the recent researches on the chemical laws which relate to the sources from which plants derive their mineral constituents, the true *rationale* of the practice is of somewhat easy elucidation. Admitting (and there cannot be a doubt on the subject) that, *cæteris paribus*, on the abundance or scarcity of the mineral constituents of crops existing in what may be termed an active state in the various soils cultivated by the husbandman depends the respective fertility of each; it will be apparent to all, that the act of burning land for manure cannot *add* anything to the soil, but can only have the effect of changing substances previously existing therein in an inert or unavailable form into an active or available form; in plain terms, into a state more likely to be rendered soluble by the joint effects of carbonic acid and water.

Respecting the dormant and active ingredients of soils a most excellent paper appeared in the last part of the 'Journal of Agriculture' by Dr. Daubeny, being a part of his Bakerian Lecture for 1845, in which he justly observes,—"Let us take the case of

a natural soil, composed of certain kinds of disintegrated lava, or even granite, in which it is even evident that an actual analysis would detect the presence of a large per centage of alkali, not improbably of a certain amount of phosphate of lime, and, in short, of all those ingredients which plants require for their support in sufficient abundance. Nevertheless land of this description, in consequence of the close union of the elementary matters of which it consists and the compactness of its mechanical texture, *might be as barren* and as incapable of imparting food to plants, as an artificial soil composed of pounded glass is known to be, notwithstanding the large proportion of alkali contained in it."

"In order, therefore, to ascertain the respective amount of the active and dormant ingredients existing in soils, the writer digested some soil for four or five successive hours in muriatic acid, justly observing that whatever cannot be extracted from a soil by such a digestion must be in such a state of combination as will render it totally incapable of imparting anything to a plant for such a period of time, at least, as can enter economically into the calculations of the agriculturist; and moreover that all which muriatic acid extracts, but which water impregnated with carbonic acid fails in dissolving, ought to be regarded as contributing nothing towards present fertility, although it may ultimately become available as food for plants."

Dr. Daubeny, therefore, first ascertained the nature and amount of the ingredients separable from a given weight of soil by means of muriatic acid; and secondly, those obtained from an equal weight by a definite quantity of water impregnated with carbonic acid gas. Thus by a careful analysis he ascertained—"That the soil of the Botanic Garden at Oxford contained within an area of 100 square feet and a depth of 3 feet from the surface 3·5 lbs. of phosphoric acid, 6·9 lbs. of potash, and 2·9 lbs. of soda, all in a state to be separated from the general mass by muriatic acid."

That the above, however, were for the most part in a dormant condition, appeared from the much smaller amount of the same which could be extracted by water containing carbonic acid; for it was found that of all the alkaline sulphates* not 11 lbs. could be procured by these means instead of 19·2 lbs.

By operating in a similar manner upon soils of the same quality as the above, which had been exhausted by several years' previous cropping, it appeared that the amount of the ingredients alluded to as *dormant* in the soil did not much vary from

* The alkalies were estimated as sulphates, as it was found convenient to unite them with sulphuric acid, in which state they admitted of being heated and weighed without incurring loss.

the above-quoted instance, but that the amount of the active ones was beyond all comparison greater in the sample of unexhausted soil.*

I shall conclude these extracts by the following quotation from the same paper:—"The dormant and active portions may both be comprehended under the designation of its available constituents, whilst those which, from their state of combination in the mass, can never be expected to contribute to the growth of plants, may be denominated the passive ones."

Every soil which is capable of yielding an abundant crop of any kind of plant, after fallowing, must be assumed to possess in itself an adequate supply of all the ingredients necessary for its support in an available condition; but it is plain that these could not have existed in an active one, or such interval of rest would not have been required for rendering them efficient.

Seeing that the inorganic constituents of plants exist in the soil in three different states, which may be termed passive, available, and active, and that in one of these only (the active) are they of service to the husbandman, it is evident that all operations which will convert the first and second into the third state will be of advantage to his labours.

When a chemist has to analyse a mineral that is refractory—in other words, of difficult solubility by the ordinary agent—it is a common practice to submit such a mineral or other matter to the agency of heat, which sometimes wholly, but generally partially, has the desired effect; the remaining intractable matter, or the whole substance, if found on subsequent trial unchanged, is mixed with some alkali, as lime, soda, or potash, and again submitted to the fire, on the withdrawal of which the constitution of the matter under investigation will mostly be found so changed as to become soluble in the ordinary solvents. It is, however, necessary to be borne in mind, that the total solution of aluminous and silicious soils is only obtained by treating the same with an excess of alkali; such an amount of alkali as is necessary for the purpose is never found in soils, and the process is only mentioned in order that the farmer may the more easily comprehend the true *rationale* of the action which takes place during the process of burning land for manure.

From the preceding observations the reader will be prepared for the information that the benefit of burning land for manure will be found most beneficial on such soils as contain the largest amount of the necessary mineral constituents of plants, in what has been previously alluded to as existing in a passive state, and

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* See Table, p. 240, vol. vii., of Journal of the Royal English Agricultural Society.

on which the agency of heat will reduce the same to an active or available form. At the head of these soils will be found stiff clays and marls; next stiff loams, and loams throughout their great variety of gravelly, sandy, &c., down to silicious or sandy soils, on which burning is utterly ruinous, except as will be mentioned hereafter. As a general rule, it may with safety be stated, that in proportion to the *stiffness* of a soil will the benefit to be derived from burning be found advantageous. As a theory this rule may be safely relied upon; there are, however, many circumstances which act as drawbacks to its general application, arising from the fact that soils variously situated may be found of equal tenacity, but at the same time of exceedingly *varied* adaptation, and requiring *varied* methods of burning in order to produce beneficial results. The *varied* circumstances here alluded to arise from the fact that soils taken from distant places may present to outward appearance the same mechanical tenuity, whilst their mineral constituents may be in a different state of mechanical division, in varied proportions, or of a somewhat altered chemical character; so infinite are these varieties, that it would be impossible, even if the limits of this paper would permit the same, to describe all the qualities and the various modes to be followed accordingly.

Two great difficulties attend the burning of stiff soils—the one arising from the heat engendered being so great as to bake instead of to disintegrate the materials composing them; the other, that the heat may not be raised sufficiently high to alter the inorganic constituents of plants contained therein from a passive to an active or available form. The first difficulty arises from permitting a too great draught of air, and consequently causing a rapid and, often through draughts, a partial but excessive combustion: the second difficulty arises from either the heaps or kiln being made up too closely or too open; in the former case, the too free access of air occasions the fires to burn languidly, and consequently deficient heat through the absence of sufficient draught; whilst, if the clay or sod is packed too closely, the absence of air retards combustion, and thus necessarily the amount of heat required for the due perfection of the process, and combustion will not unfrequently be put a stop to altogether by the interstices becoming filled with ashes, and by that means almost wholly excluding the atmosphere. As soils vary so much with respect to their capacity for burning for manure, it cannot be imagined that rules can here be laid down for every case; in fact, unless a farmer knows from experience the proper formation of heaps for burning, adapted to the soil of his farm, it will be much better for him to make a few experiments on a small scale rather than depend upon any written or oral description. If in the course of these experiments he can

enlist the aid of a neighbour or labourer practised in the art, it will greatly assist his efforts; notwithstanding such assistance, considerable practice will be required ere he becomes a proficient, as most injurious effects may from apparently trivial causes arise: as an instance I may mention that, whilst in calm weather heaps should be made as open as is consistent with arrangements necessary for a due draught, in windy weather the heaps should be formed as close and as large as possible, labourers being continually employed to stop up every crevice, particularly those on the leeward side; for which purpose the whole of the sods should not be heaped up at first, but a few be left scattered about, in order to apply in the manner named. Should the soil yield to the agency of a slight torrefaction, either through its composition being such as not to have a tendency to bake, or through a large amount of carbonaceous matters being present, it may be necessary to throw on the lee-side some shovelfuls of earth. In stating this I may say that the farmer may in tolerably open loams take advantage of such a circumstance to burn double or treble the amount of soil that he would otherwise have been capable of doing. I have experienced the benefit arising from taking advantage of such a circumstance, and can confidently recommend it to others. In arranging the heaps, both as respects size and situation, it may be observed that on stiff clays, and particularly such as only contain a small amount of vegetable matter, it will be found impossible to make the requisite torrefaction in small heaps; whilst in more open soils, or soils containing a considerable amount of carbonaceous matter, the heaps or steaddles—other circumstances being favourable—can scarcely be too numerous; for this reason, that every heap burned on soils of the quality now under consideration will torrefy the soil on which it is placed to a depth of 2, 3, 4, or 5 inches according to circumstances, thus greatly increasing the productive amount of ashes and torrefied soil, at no increase, but rather a diminution, of expense and labour. In dry weather I have frequently, when all the principal sods, &c., had been gathered up and placed in heaps, and whilst they were in the act of burning, sent men round with large rakes to rake up every particle of grass or other vegetable matter, and the small crumbly clots of soil from the size of marbles to 2 or 3 inches' diameter, which could be found between each heap, and throwing a shovelful of fire amongst the soil so gathered, by which the amount of ashes was greatly increased. Provided the weather prove favourable, this will be found a most excellent practice. The rakes I used were home-made, being merely a head composed of ash, 2 feet 6 inches long and 1½ inch square, into which twelve two-shilling-the-hundred nails were fixed, in the following manner, viz.—holes were bored in the head of the rake by an

ordinary gimlet; the nails were then made red hot, and so placed in each hole and driven up to about half the length of the shank, when they were knocked out and allowed to cool, or else put in water to cool more expeditiously. When cold, the nails can be driven into the holes previously drilled into the head by burning. Any rough straight stick may be taken for a handle, which can be affixed to the head by a piece of iron riveted to the head, with a spike attached thereto to insert into the rake-handle (8 feet long), which should have an iron ferrule at the end of it, to prevent it (the handle) from splitting. Persons in the habit of burning soil for manure in the open field should always be in possession of a few such rakes, particularly as they are extremely useful for raking up all kinds of rubbish and stubble. On soils which are very stiff, and not containing much vegetable matter, great care is required in order to form heaps that will burn thoroughly, without too great a degree of heat or too little. One of the principal rules to be observed is always to erect the sods on end (if they are not square); the three or four first sods which are placed in the middle only having their grassy sides presented to each other, each succeeding row being placed with the grassy side next to the earthy side of the preceding row; the whole to be set up as compact as possible. When the heap is thus erected of a dome-shape, fire should be applied at the top, on which an ignited sod should be placed. Any clay with a moderate degree of sward will thus, if carefully attended to, produce a quantity of ashes suitable to the wants of the husbandman. It may, and often does, happen that on clay-soils, on which burning may be deemed advantageous, no sward exists; the vegetable matter principally consisting of weeds and grasses that only partake of that character, the destruction of which in such a case will form as prominent an object with the farmer as the production of ashes. When this occurs, the best plan for the agriculturist to pursue, whether it respects the abundance of ashes to be obtained or the complete destruction of the weeds, is to burn the same in the clamp or kiln; for, in the case now under consideration, it will be found that, if the attempt is made to burn the soil by the mode previously described, only a very small amount of ashes can be procured, and the entire destruction of the weeds will be problematical, as the clots of clay will be so greatly divided, that it would be found extremely difficult to construct an ordinarily formed heap of such materials as will consume the entire vegetable matter contained therein.

Burning in clamps, or large heaps, can only be accomplished successfully by practised hands, and its due management can only be ascertained by a thorough practical knowledge of the operation,

as adapted to the *particular soil to be burned.* In illustration of this position, I may observe that Mr. Pym states, vol. iii. 'Royal English Agricultural Journal,' p. 323, "The great art is to let the clay burn slowly, which depends very much upon the proper formation of the walls" (clamps), "which are of turf, *as the ashes then turn out black* for the most part, and are considered much better than when they are red and clinking, like bricks." Again, p. 325, Mr. Pusey gives, on the authority of another correspondent, "The heat should always be slow and steady, never, if possible, *burning the clay red;* though this is very difficult indeed to manage, depending very much on the wind; and it is best effected by making heaps of not less than 60 or 100 loads each, and these will take from two to three months to burn. All inexperienced hands use too much fuel, get their fires too fierce, lay their stuff too hollow, make a great deal of smoke—whereas the less they make the better—get their heaps to a red heat, and burn them through in a week or ten days; and the consequence is, that, when these heaps are opened, instead of ashes, or lumps that will fall into ashes by exposure to the air, out roll knobs as hard and as useless as brick-ends." "Much also depends upon the size of the clay lumps, and their *state of humidity; if too dry* they will burn too fierce, *if too wet* they will not burn at all." Other writers have found *exposure of clay clods to the atmosphere* advantageous; yet in contrast to the above we have the evidence of Mr. Long,* who states, in allusion to this subject, that on his soil—a thin, dry, flinty loam upon chalk—"the only difficulty being, that many persons, and himself amongst the number, at first produced a hard substance, *more resembling brickbats than powder.*" "This difficulty he obviated by (previous to burning) well saturating the soil with water, working and treading it to the consistency of mortar; for water will separate any particles, however adhesive, and then the fire, expelling the water and the carbonic acid gas, leaves the particles previously separated, when burnt, in the state of very fine powder; and if any should not at first be quite separated, it slacks immediately on the application of liquid." Mr. Long further proceeds to state, "Having saturated the soil thus with water, as much as a spade will hold is rolled up to the size of a large cannon-ball, and is handed to a man in the kiln, who places it on the bars of the coping of the brick arches over the furnace. He places each ball as he receives it side by side, for two or three tiers, one above the other, and then lights the bavins in the furnace," &c. For further particulars, as also for the plan of the furnace, I must refer to the

* Journal of the Royal Agricultural Society, vol. vii. p. 245.

paper in question. I do so the more readily, as I conceive it contains the best account of kilns for clay-burning, together with their economical management, of any yet published. My immediate object in drawing attention to the paper here is only to show that a considerable discrepancy of opinion exists as to the state of humidity in which clay should be placed in kilns or clamps, in order to be burned for manure. There can be no doubt that both the remarks of Mr. Long and Mr. Pym are founded upon actual experience and after due deliberation, yet how opposite their conclusions respecting the state of humidity in which clay should be prior to being placed in kilns or clamps for burning! From the above-quoted description of each process, it must be apparent to all that, reversing their order, there would be the strongest probability that Mr. Long's process would not be adapted to the soil of Mr. Pym, nor Mr. Pym's process to the soil of Mr. Long—in fact, a complete illustration of a previous assertion, that the best mode of burning clay lands for manure can only be ascertained by actual experiment.

A few other remarks may also be made on the above quotations. Mr. Pym states that the great art is to burn the soil so that the ashes shall turn out black, as they are then much better than when they are red or clinking. With respect to clay being formed into clinkers, there can only be one opinion, viz. their worse than uselessness; yet if the burning process is not carried further than merely to char the vegetable matter in the clay, and thus form black ashes, it will be quite evident that the benefit derivable from an application of such ashes will be slight indeed, being merely that arising from the small portion of the inorganic constituents of plants set free from the charring of the vegetable matter existing in the torrefied clay, and probably a slight amelioration of the mechanical condition of the soil, rendering a stiff soil somewhat more porous, and consequently permitting a freer access of the atmosphere to the roots of plants. It may with safety be averred that any mode of burning clay for manure which stops short of converting the protoxide (black oxide) of iron into the red, or peroxide, is incomplete, and will not produce any strikingly beneficial results. I am aware that some change may have been made in the nature of the clay by the process described by Mr. Pym; but all the evidence tends to show that this must be mainly mechanical. Whether, however, it is possible for the process to be conducted further with safety on soils such as Mr. Pym's, is a question that can only be decided by actual experiment.

In Mr. Long's case it would appear that his soil consisted of decayed minerals and flints in the state of rubble, but not inti-

mately blended together, in which case the theory of the action of the water, and mixing the soil into mortar, becomes explicable in the following manner, viz.—when burned without mixing, the finer particles of soil are apt to be acted on by the fire; but when coarser matters become intimately mixed with the finer portions of the clay, the fire is not sufficiently strong to vitrify the coarser parts, although hot enough to flux the same when finely divided—otherwise Mr. Long's experiments would be quite in opposition to the daily practice of the brick, tile, and earthenware manufacturers, who water and tread their clays for the express purpose of rendering the same into a firm hard mass when baked. With a few remarks respecting another class of stiff soils, viz. marls, I shall conclude this part of the subject. Marls that contain a moderate amount of vegetable matter, and a considerable quantity of lime, will be found to burn easily in moderately dry weather, by being formed into heaps in the ordinary manner, viz. by heaping the pared sods into masses about four or five yards' distance from each other, and applying fire to the same. If, however, the marl consists of a tough blue character, so frequently found as a subsoil, and in a great measure destitute of organic matter, any attempt to burn the same for manure other than in a kiln will be found fruitless, and for this purpose small coal should always be used. This description of marl will generally be found the most advantageous soil to burn for manure, but the greatest caution is required in conducting the operation. If the same, from inattention, want of knowledge, or other cause, is found overburned or baked, it will generally be found that an application of cold water to the lumps will speedily disintegrate them.

Sandy soils should never be burned, except as a cleaning operation: the same remark applies to gravelly soils. On both the system to be pursued should merely consist of repeated ploughings, harrowings, &c., and raking up the weeds and other waste vegetable matters, and applying fire to them. In proportion as soils proceed from stiff clays and marls, or rather from aluminous to silicious soils, will the benefit to be derived from burning soils be found to diminish; whilst the stiffer the soil, the greater the benefit. The *ne plus ultra* of burning a stiff soil is when ashes are obtained of a deep red colour if the oxide of iron is present, and in small rounded lumps that easily crumble into a fine powder when pressed between the fingers, possessing a gritty feel: such ashes will be found to possess every mechanical advantage and all the beneficial chemical changes which fire is capable of giving to soils. Deep vegetable soils, as bogs and peat-mosses, are greatly benefited by paring and burning, for which purpose the land should be pared by the breast or push

plough, Dutch plough, or shim, cross-cut and torn about with a harrow or cultivator, and then drawn into heaps by a horse-rake. In this manner, especially where the Dutch plough is used, an extensive breadth of land can be thus cultivated at a cheap rate and in a short period. Should, however, the weather be dry, great care must be taken that the heaps do not form pit-holes, in consequence of the fire penetrating deep into the soil. On these soils the beneficial action of burning is also mechanical and chemical—mechanical in an opposite view to burning clay, as on moory soils the ashes tend to consolidate an otherwise too porous soil; and chemically by the same mode which attends the action of fire *on all soils*, which has been sufficiently dilated upon already.

Clamp-burning is effected by erecting the clay-sods, &c., into large heaps of from 30 to 400 loads, with small spaces, as flues, left at intervals. Soils burned in this manner which contain only a small amount of vegetable matter will frequently require the aid of furze, underwood, small coal, or other inflammable matter, to assist the operation. Unless fagots or furze can be obtained cheaply, or coals are very dear, the latter will in general be found least expensive. There exists on all the coal districts a great amount of stiff clays and marls that could be burned advantageously and cheaply by using some of the carbonaceous shales which are now thrown aside, and form enormous heaps at the mouths of coal-pits, that are not adapted to household or manufacturing purposes, yet contain sufficient inflammable matter to burn clay: the hint is worth attending to. In burning soils of every description this must be ever kept in mind, that, unless the farmer returns an equivalent to the soil, in the form of manure, for the crops taken from it after burning, clays or any other soil will speedily return to their original infertility. Taking crops after burning, without returning such equivalent, are merely drafts on the resources of posterity, as soils, such as the Botanic Garden at Oxford, would by such means be deprived of the whole of the mineral constituents of plants contained therein in the course of ten short rotations. It is the practice so injuriously resorted to by farmers, of taking crops from burned land without restoring an equivalent, that has brought the practice so unjustly into disrepute, as it may safely be averred that there is not a practice in the course of husbandry so advantageous as an assistant to the fallow season as that of burning land, on all descriptions of soils, except poor sands, gravels, and rubbles. On downs it has been found advantageous, and particularly so on chalk soils which have been some years previously under sainfoin. This might be expected, as sainfoin sends its long roots many feet into the interstices

of the chalk, drawing thence a supply of inorganic constituents not attainable by the ordinary implements of husbandry, but which are yielded up in a great measure to the surface-soil when the roots, &c., are burned. For preparing the land for burning no implement is so useful as the Dutch paring-plough, with a revolving coulter. The Berkshire shim is also a useful implement for such purpose. The push or breast plough is better adapted to moss-land than any other description of soil. Paring with an adze, called in the West of England "a baating-axe," or "raibb batt," or paring mattock, is very generally practised in Ireland, where it is the only method pursued for paring land prior to burning, and is called graffing in that country. I had an opportunity of comparing the cost of such operation, when accomplished by this implement, in contrast with the Dutch plough; and although a "graffer" cannot earn more than 1*s.* per diem at this work, I found the plough did the business at half the expense; in fact, this and the push-plough should only be used in difficult or extraordinary cases, as horses and ploughs will generally be found least expensive and under the more immediate control of the farmer.

Sufficient has been said as to the modes of burning land. It may, however, with propriety be here remarked, that, when the surface-soil is to be burned for manure in small heaps distributed over the field, paring by the plough, and subsequently cross-cutting, scuffling, and harrowing the same, will be found the least expensive mode of preparing the same previous to burning. On soft peaty soils the whole operation, including spreading the ashes, may be done for about 12*s.* 6*d.*; on clays, or stiff soils, according to their nature, it will cost 25*s.* to 30*s.* per acre, which will be found the least expensive mode of fallowing.

Burning clay in clamps will cost from 4*d.* to 6*d.* or 8*d.* per cubic yard; burning clay in kilns will cost from 8*d.* to 9*d.* per cubic yard, and 80 cubic yards of clay may be considered a fair dressing per acre.

Provided an adequate return is made to the soil for the crop taken off after burning, no injury will be sustained by it, except on thin gravelly and sandy moors, much intermixed with vegetable matter, on which paring and burning will be found most destructive, as it destroys the staple of such soils. All such, and sandy soils, should never be burned, except after well weighing the advantages and disadvantages likely to arise therefrom. Generally on such soils the disadvantages will be found to preponderate.

IV.—*Report of an Experiment with Special Manures, as applied to the Growth of Turnips in the Summer of* 1846. By Thomas Page.

To Charles Barclay, Esq., Bury Hill.

Sir,—In compliance with your request, I beg to present you with a Report of the experiments made with Special Manures for the Growth of Turnips, on your estate during the last summer.

In order that the nature of the several experiments may be the better understood, and consequently a more correct estimate formed of their different results, I will state as briefly as possible the nature of the soil, the course of cropping which it had previously undergone, and the preparatory cultivation of the land for the crop; together with any other attendant circumstances which may serve to illustrate the subject.

The nature of the soil in question is a light blowing sand, very shallow, with a considerable quantity of rubbly surface-stones, resting on a subsoil of sandstone rock. In point of quality, I believe I am justified in saying, it is almost as poor as any land in the county of Surrey. The part of the farm chosen, on which the trial took place, was a field of ten acres in extent, an old ley of three years' standing, the layer commencing immediately after a crop of oats. The land was broken up with the plough as deep as it was possible to go, in the autumn of 1845. In the following April the land was again ploughed, in an exactly opposite direction to that taken in the autumn. The plough was never again used, the cultivation being completed by the use of Biddel's scarifier; the couch and roots of the grasses were collected by Grant's lever horse-rake, some small part of which was burnt on the land for the sake of expedition, and the remaining greater portion carted to the yards.

From the backwardness of the season, and the multiplicity of work which necessarily attends an extensive breadth of turnips, the sowing was delayed till the 22nd and 23rd of July. The seed and manure were deposited by a drill manufactured by Smyth, of Suffolk, worked by two horses, drilling 3 rows at 18 inches apart at each breadth. The kind of seed the "red round."

The field was divided into ten portions, containing an acre in each; but owing to some part of the manure not being sufficiently dry to work quite properly, the divisions first made were necessarily altered, which will account for there being but nine portions mentioned below.

I here subjoin a tabular statement of the quantities and kind of manure applied to each portion, together with the cost of each, and also the weight of the whole produce per acre:—

A Particular of the Quantity and Description of Dressings applied for the Growth of Turnips, on the Ten Acre piece of Land at Merriden; with the Cost of each kind, and the Weight of the produce per Acre.

No. of the Piece of Land.	Quantity of Land contained. a. r. p.	Description of the Dressings applied.	Quantity of each kind used, with their respective costs.	£. s. d.	Cost per Statute Acre. £. s. d.	Weight of Roots per Statute Acre. tons. cwt. qrs. lbs.	Weight of Tops and Tails per Acre. tons. cwt. qrs. lbs.	Total Weight of Produce per Statute Acre. tons. cwt. qrs. lbs.
1	1 0 0	Crushed Bones and Turf Ashes.	8 bush. Bones, 2*s.* 6*d.* 16 ,, Ashes, 5*d.* .	1 0 0 0 6 8 1 6 4	1 6 8	9 1 3 20	3 0 2 16	12 2 1 36
2	1 0 0	Crushed Bones, Turf Ashes, Nitrate of Soda, and Nitrate of Potash.	8 bush. Bones, 2*s.* 6*d.* 16 ,, Ashes . . ½ cwt. Soda, 23*s.* . ½ cwt. Potash, 33*s.* .	1 0 0 0 6 8 0 11 6 0 16 6 2 14 8	2 14 8	10 1 1 20	3 0 1 4	13 1 2 24
3	1 0 30	Crushed Bones dissolved in Sulphuric Acid, Turf Ashes, and African Guano.	4 bush. Bones . . 84 lbs. Acid, 1*d.*. . 16 bush. Ashes . . 1 cwt. Guano, 8*l.* 10*s.*	0 10 0 0 7 0 0 6 8 0 8 6 1 12 2	1 7 1	12 0 2 24	3 1 2 24	15 2 1 20
4	1 0 30	Crushed Bones dissolved in Sulphuric Acid, Turf Ashes, African Guano, Nitrate of Soda, and Nitrate of Potash.	4 bush. Bones . . 84 lbs. Acid, 1*d.* . 16 bush. Ashes . . 1 cwt. Guano. . . ½ cwt. Soda . . . ½ cwt. Potash . .	0 10 0 0 7 0 0 6 8 0 8 6 0 11 6 0 16 6 3 0 2	2 10 8	14 1 1 4	5 0 1 4	19 1 2 8*

5	1 0 0	Muck of an ordinary kind, African Guano, and Turf Ashes.	8 cart-loads of Muck at 4*s*. . . . . . 3 cwt. Guano . . 20 bush. Ashes . .	1 12 0 1 5 6 0 8 4 3 5 10	3 5 10	13 1 2 24	5 0 0 0	18 1 2 24
6	1 0 0	Muck, African Guano, Turf Ashes, Nitrate of Soda, and Nitrate of Potash.	8 loads of Muck . . . 3 cwt. Guano . . 20 bush. Ashes . . ½ cwt. Soda . . . ½ cwt. Potash. . .	1 12 0 1 5 6 0 8 4 0 11 6 0 16 6 4 13 10	4 13 10	13 1 0 10	4 0 0 16	17 1 0 26
7	1 0 30	Muck, Crushed Bones dissolved in Sulphuric Acid, and Turf Ashes.	8 loads of Muck . . . 4 bush. Bones . . 84 lbs. Acid . . . 16 bush. Ashes . .	1 12 0 0 10 0 0 7 0 0 6 8 2 15 8	2 6 0	7 1 2 26	3 0 1 20	10 2 0 18
8	1 0 30	Muck, Crushed Bones dissolved in Sulphuric Acid, Turf Ashes, Nitrate of Soda, and Nitrate of Potash.	8 loads of Muck. . . 4 bush. Bones . . 84 lbs. Acid . . . ½ cwt. Soda . . . ½ cwt. Potash . .	1 12 0 0 10 0 0 7 0 0 11 6 0 16 6 3 17 6	3 4 10	12 0 0 0	3 1 1 4	15 1 1 4
9	1 1 0	Muck, Crushed Bones dissolved in Sulphuric Acid, Turf Ashes, and African Guano.	8 loads of Muck . . . 4 Bush. Bones . . 84 lbs. Acid . . . 1½ cwt. Guano . . 16 bush. Ashes . .	1 12 0 0 10 0 0 7 0 0 12 9 0 6 8 3 8 5	2 14 8	12 1 2 20	3 1 3 8	15 3 2 0

* By measure 820 bushels per acre, weighing 40 lbs. per bushel.

It should be observed that the field was as nearly as possible of uniform quality; and the cultivation, both previous and subsequent to the sowing, on all parts exactly alike.

The weight of top and tail per acre may seem small in proportion to the weight of roots; but it must be remembered that the weighing took place immediately after a month's unusually severe weather, the land being at a considerable elevation and very much exposed. The crop was hand-hoed twice, and thrice horse-hoed.

On all the portions where dissolved bones were used, the plants came forwarder to the hoe than where they were not used; but beyond this there was not much perceptible difference in the appearance of the different parts, until from a month to 6 weeks had elapsed, when No. 7 began to grow less rapidly than the rest. At the end of between 7 and 8 weeks No. 1 began to fall off; and in a few days No. 2 followed. Further than this difference, the eye could hardly detect where the separation of each kind of dressing took place.

It will doubtless be looked upon by some as rather a curious account; but I am persuaded that it is by making experiments such as these we shall *practically* arrive at that knowledge so much to be desired, viz. *the specific dressing which each crop requires, and how this shall be varied to suit the different descriptions of soil.*

The crop of turnips, which, by the by, are considered exceedingly good, are now being fed off on the land; after which, it will be sown with barley, cow-grass following. The growth of these crops will be narrowly watched, and any particular effects which may be noticed will be reported at a future period.

I am, Sir,

Your very obedient humble servant,

Holmwood Farm, Dorking, Surrey, THOMAS PAGE.

11th February, 1847.

V.—*On the Management of Wheat.* By EDWARD ROBERTS, Jun.

PRIZE ESSAY.

1.—*Preparation of the Land according to variety of Soils.*

WHEAT, the most valuable of grains, is grown upon nearly every description of land; but the soils best adapted for its culture are those which are more or less clayey: indeed these heavy soils are so peculiary fitted to its production that they are frequently dis-

tinguished by the appellation of "good wheat-land." It is well known, however, that wheat will grow to high perfection upon almost every soil, when the land is properly prepared for it.

Whatever may be the nature of the soil, it should always be the aim of the farmer to grow full crops: partial and sometimes extensive failures will even then but too often occur; but to neglect making the best-known preparation, or only to prepare for half a crop, is an ill-judged notion, and has a direct tendency to unremunerating farming.

In order to prepare for luxuriant crops, the land, when of a wet nature, must be liberated from all surplus water by proper under-draining; it must be clean from couch-grass and all other kinds of rubbish; not tired out by cross or improper cropping; must be judiciously manured, but not overdone with it, inasmuch as too much manure causes the growth of an unnaturally large quantity of straw, which, if the season happens to be wet or stormy, will be crippled and flat on the ground before the ears could come to perfection. When this happens, it both lessens the quantity, and very much deteriorates the quality of the grain. The land being otherwise well prepared, it is perhaps upon the whole more desirable to have a little deficiency of manure than too much, as, if necessary, a partial top-dressing may always be added in the spring. The land must not be wheated oftener than the soil will admit: some soils will bear it more frequently than others, and it is essentially necessary that the kind of seed should be adapted to the description of soil upon which it is to be propagated. An entire change of seed from hot land to cold, and from cold land to hot, will always be found advantageous, and especially from hot to cold soils, in which case it will frequently bring the harvest nearly a *week earlier*. In both cases it is generally allowed to increase the yield, improve the sample, and preserve the stock in greater purity.

It has now become very general to sow wheat after clover upon all classes of soils. This is doubtless one of the best systems of growing wheat: the roots of clover after becoming decomposed afford much nutriment to the growing wheat, and the firmness given to the land is another great recommendation. It has been frequently observed when the plant of clover has been deficient that the wheat-plant fails also. This, however, is not always the case: at the same time it serves to show a peculiar adaptation, on many soils, to the growth of wheat after clover. There are several other methods of preparing land, varying according to the nature of soils, which oftentimes produce crops of the first order. Some of these are as follows:—

1st, *Upon clayey soils*, a full summer's fallow is occasionally resorted to as a preparation for the wheat-crop on much of the

land in Essex, Hertfordshire, Bedfordshire, and other counties, particularly when the land becomes foul with couch-grass, &c., and cannot very well be brought into a thorough clean state of cultivation by partial fallows, connected with the growth of green crops. Considerable benefit is also derived from summer fallowing upon this kind of soil, as it causes a more perfect decomposition of its constituent parts. This latter effect has been proved in many cases by experienced farmers, and has come under the observation of the writer. For instance, when this kind of land has been repeatedly dunged, better crops have frequently been obtained after a full summer's fallow without dung, than after a good dressing of dung without a full summer's fallow. In illustration of this statemtent, Professor Liebig, in his work on the 'Chemistry of Agriculture,' says—"In the effect produced by time, particularly in the case of fallows, or that period during which a field remains at rest, science recognises certain chemical actions which proceed continuously by means of the influence exercised by the constituents of the atmosphere upon the surface of the soil;" and in another place he says—"It is quite certain that careful ploughing and breaking up of the soil, by producing the change and increase of its surface, exercises a very favourable influence upon its fertility." At no very distant period farmers generally considered systematic summer fallowing to be one of the most important points of agriculture; and there are some in the present day who have proved its peculiar suitableness to a few of the wet clayey soils; though many speak of it as an unnecessary waste of labour, and a sacrifice of the produce of the land.

In some parts of the midland counties, upon the heavy soils, where a summer's fallow is the preparation for wheat, about July or the beginning of August, when the soil has been thoroughly cleaned and pulverized, it is formed into two bout stitches 1 yard wide, and manured in precisely the same way as for turnips, putting on from 8 to 10 cart-loads per acre: others spread the dung on the surface and plough it in, forming their land into stitches from 2 to 8 yards wide. In both cases the land should remain untouched from this period till the time of sowing. In the latter case the seed is drilled in rows from 6 to 10 inches asunder. When labour is plentiful the dibbling process is often adopted, and then a less quantity of seed is sufficient. The horse-hoe is sometimes used to cut up the annual weeds immediately previous to sowing, which frequently grow very strong, and would be too much for the harrows to eradicate. When the former plan is adopted—namely, that of ploughing the land into two bout stitches—the plough is sufficient, and there is no necessity for the horse-hoe. The seed is sown under the furrow in the "spraining"

method; one seedsman to two ploughs, which merely reverse the ridges that were made when the land was dunged. Small light seed-ploughs are kept for the purpose, which leave a narrow furrow. Many farmers object to this method because of the numerous furrows; but this is an erroneous idea, for when wheat is drilled or dibbled the space between each row is often more than the width of one of these furrows. Others object to it because the wheat comes up similar to the broad-cast system, and they cannot very well hoe it in the spring; but this is no valid objection, for if a fallow has been properly managed the wheat will scarcely require hoeing, since, by continually moving the land during the early part of the summer, most of the seeds of annual weeds have been brought sufficiently near the surface for germinating; and the land being left quiet from the end of July until seed-time gives every encouragement for the weeds to grow; there are consequently but few seeds near enough to the surface for vegetating in the spring. Three men, with two ploughs and four horses, can put in by this system about 3 acres per day. Last year, upon an extensive farm known to the writer, more than half the wheat was sown in this way, and proved remarkably fine, even more so than that sown after clover.

In some parts of Scotland the wheat is sown with a drill-plough, which drills the seed, and covers it in with the furrow turned by the plough: the crop, of course, comes up in drills, and this method is considered to prevent the wheat losing plant on wet and loose soils.

It is well known that wheat should be sown when the land is *clung*, and it is considered better to wait and have a late season of sowing than to put it in when the soil is in a dusty state; which, upon some land, causes the wheat to become root-fallen, and upon soils of a closer texture, where this does not occur, the wheat seldom flourishes so well as when put in after rain. The land is never too wet for sowing wheat, provided it works at all kindly, and the seed can be effectually covered. There are, however, some soils of a peculiar mixture of sand and clay, which, if stirred when very wet, will run together, and afterwards in dry weather form a hard crust, which of course checks the growth of the plant.

The best period for sowing wheat on cold clayey soils is from the last week in September to the middle of October, as it seldom becomes winter-proud upon such land.

Many think that water-furrowing may be entirely dispensed with where the land has been thoroughly under-drained, but this opinion is not borne out upon very heavy tenacious clays. I have observed that upon such soils the surface-water has not gone off sufficiently quick without it.

When this or any other kind of land has been previously got into a high state of cultivation, it is frequently cleaned and made ready in the autumn for dunging in the spring, and then sown with turnips or mangold, which are usually carried off in the autumn and the land sown with wheat. But sometimes the roots cannot be removed till late in the season; the time of sowing is then sometimes delayed till January or February, when spring-wheat is generally sown. Upon ordinary heavy soils that have a dry subsoil and do not require draining, white turnips, grown upon the fallows and fed off with sheep during the months of October and November, are an excellent preparation for wheat. When this plan is adopted, wheat is generally grown three times in a double four-course system of 8 years, namely—1st year, fallow for turnips; 2nd year, wheat; 3rd year, beans or peas; 4th year, wheat: the next round being—5th year, fallow for swedes; 6th year, barley; 7th, clover; 8th, wheat. Upon some soils a heavier and better sample is produced after turnips than by any other preparation.

Wheat is often sown after beans. In this case dung should be applied for the beans, which if kept clean will be a good preparation for wheat. This is preferable to dunging immediately for wheat, which often occasions blight; but, by having an intermediate crop of beans, blight is generally prevented, and better crops, both of wheat and beans, are produced. If farm-yard dung cannot be obtained for the beans, rape-cake drilled in at the time of sowing the wheat at the rate of from 8 to 16 bushels per acre will generally be found sufficient to produce a crop.

On the heavy clay lands of Norfolk and Suffolk, barley has taken the place of wheat after fallow, and the wheat either follows clover or beans and peas; the rotation commonly adopted being—1st year, fallow; 2nd, barley; 3rd, half clover, half beans or peas; 4th, wheat. The dung is applied to the pulse by the best farmers, and the crop is well hand or horse-hoed. Wheat is drilled after beans, though hand-dibbled by many after clover. Farm-yard manure is used heavily on clover-layers, either on the young seeds during winter, or a short time before ploughing the land for wheat. The former method is preferred by many, because the clover has the benefit of the dung, and the wheat comes "kindlier." This system of exposing the manure to the atmosphere will appear to tell against the generally-approved method of ploughing it in: at the same time, admitting that much of its virtue evaporates into the air, yet the clover absorbs a portion of that part of the manure which suits its growth, leaving such properties to be taken up by the wheat which are peculiarly beneficial to it. The system of growing grain-crops on the retentive clayey soils of the eastern counties is one that might be followed with some advantage on

much of our heavy wet land, particularly that which is ploughed in "high-backed" lands. In travelling through a heavy land district how often do we see these wide and round lands laid up to an enormous height by repeated ploughings in one direction, under the fallacious idea of draining the land; but how seldom does it answer the intended purpose; though it has this disadvantage, that the crop in the furrow bears no proportion to that on the ridge. There is also great injury sustained in the cultivation of the land, particularly in the operations of drilling or sowing the wheat-crop, for there is not only the inconvenience, which arises from the rounded form of the land, in carting and tillage, but there is also a very great amount of injury from the treading of retentive land. This is in a great measure prevented by the system of clay-farming more particularly adopted in the eastern counties, Norfolk and Suffolk, which are the acknowledged seat of the origin of drill-husbandry. In those counties we see the width of lands or "stitches," as they are termed, adapted to the size of the drill, either for one stroke or for a bout of the machine; and the horses, in drilling, harrowing, rolling, and other tillage operations, invariably walk in the furrows without trampling the soil.

Upon most of the light chalky or gravelly soils wheat generally succeeds clover or trefoil; but in cases where the plant of clover fails, early peas are occasionally substituted, and as soon as the peas are removed the land is sown with either coleseed, white mustard, or tares, which are fed off with sheep, as a preparation for wheat, and generally succeeds perfectly well. The clover or trefoil is ploughed flat and shallow, the land rolled with a heavy roll. The grooved drill-roller and Crosskill's clod-crusher are both excellent implements for this purpose, though the drill-roller can be used when the land is too moist for the clod-crusher to make effective work, and it raises a greater quantity of mould for the drill. Rolling after the seed is sown, treading or folding with sheep, are means adopted for the purpose of consolidating the soil, and by that means preventing the plant being thrown out, and also for stopping the ravages of the wire-worm. The process of claying light sandy or gravelly soils is essential for the production of a good crop of wheat; it supplies materials that are wanting in the soil, improves its mechanical texture by making it more adhesive and less liable to be acted upon by continued drought. It is commonly found that a greater quantity of seed per acre is used on the light soils than on any other kind of soil; the end of October is considered the best time of sowing.

Upon rich, deep, dry, loamy soils, wheat is successfully cultivated after potatoes, the potatoes being removed at the latest in October. It is no uncommon thing on some tracts of land—such as are extensively found in the neighbourhood of East Ham,

Barking, Romford, Edmonton, Enfield, and other places—to grow wheat and potatoes alternately for many years together. But in order to carry on this system successfully, dung must be liberally used for the potatoes; no dressing beyond this is required for the wheat; the potatoes yielding from 300 to 500 bushels per acre, and the wheat from 30 to 40 bushels. Of course, as above hinted, to carry on this kind of farming, manure must be made rich and applied abundantly, or be obtained plentifully from large towns. Upon this description of land 4 pecks of seed are amply sufficient, and it should never be sown till the end of October or the beginning of November; if at all earlier, it becomes winter-proud and produces too much straw. I have witnessed the large yield of full 50 bushels per acre throughout a field of 37 acres in the parish of East Ham, in Essex, where the seed was not sown till the middle of December, after a full crop of potatoes. Upon other strong yet rich loams, containing a larger proportion of clay, wheat and beans are successfully cultivated alternately. The beans, being kept perfectly clean, frequently supersede the labour of ploughing for wheat; in which case the land is harrowed previously to drilling or dibbling the wheat.

Peat-soils are of so loose a texture that they require to be rendered as solid as possible by a good drainage—for peat holds water like a sponge, and when the water is carried off it contracts in a similar manner—by the admixture of clay or other inorganic substances, and by rolling and pressing before and after planting, to insure a medium quality of grain. As these improvements go on in the fens of Lincolnshire, Cambridgeshire, &c. &c., the quality of grain brought to market approaches nearer to that grown on sandy and loamy soils, while the quantity greatly exceeds the corn grown on light sands or gravels. The fen-farmers have one advantage with respect to the growth of a good quality of grain, which is the absence of hedges and of hedge-row trees. A preparation which appears adapted for peat-soils is to plough the land shallow, drill-roll, and hand-dibble the seed in the grooves formed by the roller, and then cover the seed with the harrow. The solidity given to the soil by this method is what is absolutely necessary on the spongy peat-soils. The rolling, and treading, and depth at which the seed is deposited prevent the plants being thrown out by alternate frosts and thaws; and, giving the root a good hold of the soil, in some measure prevent also the crops being lodged or becoming root-fallen. With respect to dibbling, we may observe, that it is acknowledged to be the means of obtaining a stiffer straw; and hence the propriety of hand-dibbling at a cost of 7*s.* or 8*s.* per acre on a loose peat.

On freshly broken-up grass-land oats are preferred to wheat; though, after the surplus vegetable matter of the soil has been

reduced by burning, tillage, and the mechanical application of suitable earthy matter, wheat can be grown of good quality. Of course these remarks on fresh broken-up land are general, though not applicable to every case.

It is an acknowledged fact, applicable to every description of soil, that the land prepared for wheat cannot be too stale or solid, provided it be free from weeds, and the surface sufficiently mouldy to cover the seed.

2. *The application of Dung or Artificial Manures.*

If a sufficiency of farm-yard manure could be obtained there would be little necessity for any other, inasmuch as it contains all the ingredients requisite for producing every kind of crop. But let it be understood that the dung should be composed of the excrements of animals well fed under cover.

It has been before observed, that when dung is to be applied in liberal quantities for the benefit of wheat, it should, if practicable, be put on the land previous to sowing a preceding root or pulse crop; for thus those ingredients of the dung, which only tend in their first effect upon the land to force an over-abundant growth of straw, will have been extracted, leaving the land in a good state for wheat. Where root or pulse crops are not grown the dung should be applied to naked fallows for wheat as early in the summer as possible.

Though the practice of manuring immediately before sowing the wheat is objectionable, it is still adhered to in many parts of the country.

A compost of earth and dung is highly beneficial on light chalky and silicious soils.

Four or five loads per acre of farm-yard manure and half a folding with sheep are a good manure for wheat, and frequently adopted by the farmers of the midland counties.

A very large proportion of land is manured for wheat by means of the sheep-fold alone, especially upon dry soils, where great benefit is derived by its solidifying the ground; it has also a tendency to kill the slugs and other destructive insects, or at least to put a stop to their ravages. Folding upon fallows is likewise adopted with advantage; upon loose light soils, folding after the wheat is sown is of advantage.

Some farmers adopt the plan of ploughing green crops in; but others consider it a better plan to convert all green crops into animal manures, by feeding off with sheep or by soiling.

Pigeons' and hen-house dung are frequently used as a top-dressing for wheat, and are almost sure to be beneficial on any soil. From 30 to 40 bushels are used per acre. Like all other

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light manures, it is best covered by means of harrowing or hoeing, or it may be drilled between the rows.

Soot is much used as a top-dressing for wheat, and is commonly found very beneficial. From 40 to 60 bushels per acre are generally applied. It has a tendency to increase the quantity and improve the quality of the wheat, without forcing an undue quantity of straw. It should be sown in February or March at the latest. It is however frequently sown as late as the month of May; but if a dry summer follows, it is in that case of little or no value. As ammonia is the principal ingredient of this manure, it should be covered by means of the hoe or harrow, being liable to waste by evaporation; and, as it is a very light substance, calm and showery weather must be chosen for applying it. This manure is found to be peculiarly suited to the county of Hertford, and consequently a very large proportion of the soot made in the metropolis comes into this county. It has been used in Essex, Kent, Middlesex, and other counties, but in most cases without general beneficial results.

Rape-cake is a valuable manure for wheat. It may be applied at the time of sowing the seed, or drilled between the rows in the spring. From 8 to 16 bushels per acre are generally found sufficient. It is best adapted to ordinary heavy soils that are well drained, or have a dry subsoil.

Malt-dust, to the extent of from 30 to 50 bushels per acre, is occasionally used as a top-dressing for wheat.

Bones may be applied with much advantage upon dry soils previous to sowing the wheat, at the rate of from 16 to 30 bushels per acre.

Guano, at the rate of from 2 to 3 cwt. per acre, is sometimes advantageously used at the time of sowing the wheat. This manure is found most beneficial on poor loamy soils.

The nitrates of soda or of potash are occasionally used at the rate of from 1 to 3 cwt. per acre, and applied broadcast in March or April. Chemical analysis has proved that wheat always contains a much larger proportion of potash than of soda; hence we may suppose that nitrate of potash is the best of the two: it is, however, the most expensive. As to the application of nitrate of soda to wheat when it has a yellow or sickly appearance in the spring, if finely pulverized, and sown in moist weather, it will in a few days alter the sickly hue to a luxuriant green. As it increases the quantity of straw, it is best suited to poor loams and gravelly soils.

Common salt is sometimes applied before sowing the seed, at the rate of from 10 to 21 bushels per acre, and is often beneficial in bringing the ears to perfection: it also causes a greater weight of grain, but seldom increases the quantity of straw.

These are the principal manures that have been proved to be useful for wheat. There are many others; but even a bare enumeration would occupy too much space.

3. *The time of Sowing.*

The time of sowing wheat varies with the nature of the soil. Upon very strong clays or cold soils the plant has been known to flourish best when sown as early as the middle of September. It takes a firmer and deeper hold of the soil before the frost commences, and there is no danger here of its becoming "winter-proud." Sowing early on this class of soils not only insures a better crop, but brings it much earlier to harvest. Wheat seed-time upon these soils begins about the 20th of September, and lasts till towards the end of October. Wheat sown at the former period has been known to be nearly a fortnight earlier to harvest than that which was sown a month later.

Upon warmer soils, as before observed, the best period of sowing is from the last week in October to the last week in November. If sown earlier, the plants get too forward, and do not mat on the ground; the plants become weak, and spindle into a long slender stalk, and frequently lose their healthy appearance in the spring. Varieties of spring-wheat are sown in February and March, and succeed on good land, though a productive crop is rarely seen on inferior sands and gravels.

Observations having been made on the time of sowing in treating of the preparation of the land, any further remarks are uncalled for.

4. *The Quantity of Seed.*

The necessary quantity of seed varies from 4 to 10 pecks per acre. It depends entirely upon circumstances, as the time of sowing; the manner of sowing, whether broadcast, drilled, or dibbled; when sown early, it requires less seed than when sown late; the nature and condition of the soil, the variety of wheat, and the quantity of vermin that consume the grain before or after it vegetates,—all have some effect on the quantity of seed required. The poorer the land, the more plentiful must be the seed. On a poor gravelly soil, where an abundance of manure is not attainable, 10 pecks are requisite, drilled at from 6 to 8 inches; and we find, from observation of both wet and dry seasons, that when this quantity is at all sensibly decreased, or the intervals between the drills increased to a material extent, the crops suffer a diminution both in quantity and quality.

When the land is good, very little seed is required, for it always branches out in the spring; but on poor land, when sown late, many of the plants die, at the same time that others on good

land are preparing for numerous branches. Nothing definite, therefore, can be named as to the proper quantity to be sown. Upon the broadcast system, where $2\frac{1}{2}$ bushels per acre are sown, it is generally allowed that, if drilled, 2 bushels would be equivalent, and if dibbled 5 pecks. As an instance of the effect of time, I may mention that upon a poor heavy soil, if we commence in September with 2 bushels, by the middle of October we increase it to $2\frac{1}{2}$ bushels per acre.

It has been repeatedly proved that upon land of the best quality, and in high cultivation, if dibbled and put in perfectly regular, 4 pecks of seed per acre are better than more, inasmuch as it leaves a roomy and healthy space between the plants, encourages branching, and produces stiffer straw, with plumper ears, than when sown thicker, and upon the whole gives the most certain and fullest production that the land is capable of. Thickly-sown wheat on rich land grows much weaker straw, smaller ears, and is liable to fall down long before the usual time for coming to perfection.

We have heard of transplanting wheat, and I can assign no good reason why it should not be more generally adopted. It is true it would be a somewhat tedious operation to plant many acres in this way; but when it is considered what a small portion of seed would be required, it might repay the farmer for his trouble and expenditure.

Varieties of wheat differ in their tillering properties. The following experiment was made in 1843:—

October 28th, 1843, planted 30 kernels of 6 varieties of wheat, with a view of testing their tillering property, and the time at which they arrive at maturity. The wheat was dibbled, one kernel in a hole, at equal depth and distance, on a piece of loamy ground. The varieties each formed a row, distant from each other 10 inches, and from plant to plant in the rows 4 inches. The table given below will show the result of the experiment:—

Variety.	Number of Seeds vegetated.	Time of coming into Ear.	Number of perfect Ears.	Number of Ears from one Grain.
Bellevue Talavera White	26	June 3	234	9·0
Marygold or Rattling Jack Red . . .	26	„ 14	134	5·1
Spanish Talavera White	26	„ 8	203	7·8
Spalding's Prolific Red	27	„ 14	155	5·7
Jonas's Seedling White	26	„ 12	168	6·4
Shirreff's Hopetoun White	25	„ 12	191	7·6

The Spalding's and Marygold are the most productive of the 6 varieties, though in this case they tillered less than any of the other kinds.

5. *The varieties of Seed and the change of Seed.*

The variety of wheat must be suited to the soil and climate; and the knowledge of the varieties best suited to a particular soil can only be obtained from the experience of the farmers who cultivate that soil. It is, however, bad judgment to be so far prejudiced in favour of one sort as to cultivate it to the exclusion of all others. The best kinds deteriorate in course of time: new varieties are constantly being introduced, some of which would in all probability be found superior to the old.

More wheat is now produced per acre, by greater attention being paid in choosing the most prolific kinds. It should, however, be borne in mind that the most prolific are also very frequently of a coarse quality, and commonly lose in price what they gain in quantity. At the same time it is admitted by those who have put the question to a test, that the most productive are often the most advantageous to the grower. Instances, indeed, have occasionally occurred where heavy white wheat of the finest quality has been tried by the side of a coarser description, and has equalled it in quantity; but this must be considered an exception to the rule, and not the rule itself.

On rich soils, where an abundance of straw is produced, short and stiff-strawed wheat yields the best crop, as the weak and long-strawed wheat is liable to be spoiled by being laid. Such varieties as Spalding's Prolific and Piper's Thickset are suitable for rich land. On very productive wheat-land in Norfolk, Piper's Thickset produced such abundant crops, that on its introduction into that county it at once obtained the name of Protection Wheat. On the contrary, short-strawed wheats like Piper's Thickset are very inferior to long-strawed wheat on land that yields a light crop. Mixed wheat (red and white) is sown in some parts of the country, care being taken to select two sorts that ripen at the same time. It is considered that two varieties are more likely to produce a certain crop than one alone; for undoubtedly it frequently occurs that one kind produces the heaviest crop one year, and another the next; and when equal portions of red and white wheats are sown together, sometimes the white and sometimes the red predominates in the sample that is produced. It is well known that a mixture of red and white wheats commands a higher price in the market than red alone.

During the last few years many new sorts of wheat have been introduced, though some are but new names for varieties long well known. Some are noted for the earliness of their growth,—among these are the Bellevue Talavera, Mexican Vicario, and the bearded April wheat, which are all recommended for spring-sowing; but it has been confidently asserted, from observation, that the two

former, though of superior quality, do not on a gravelly soil, in a dry climate, produce an average crop, if spring-sown; besides this, the grain adheres with such tenacity to the chaff, that there is extreme difficulty in thrashing them with the machine.

Among other faults which some varieties possess is an incapability to withstand severe weather, liability to shell when harvested, or to grow in the ear, to which very chaffy kinds are more especially subject.

The advantages to be derived from a change of seed from a hot to a cold soil, and *vice versâ,* has already been mentioned. Plants removed from one climate to another will in some measure continue in the same habit of growth. Thus seed brought from a warm country will produce an early crop, though it will be inferior in hardihood to plants grown from seed brought from a cold climate; and it will be found, that, whilst the latter improves by cultivation, the former deteriorates.

The following is the result of an experiment tried last year upon red wheats by Mr. J. B. Brown, Elms Hall, Colne Engaine, given to the public, which will be found to contain valuable information :—

——	Quantity per Acre.			Weight per Bushel.	Weight of Straw per Acre.	Bushels of Chaff per Acre.
	b.	p.	p.	lbs.	lbs.	
1. Colne White Chaff	42	3	4	62	3250	90
2. Bristol	39	2	12	63½	3515	75
3. Sharp's, Goody's, or Crabb's	39	0	14	64	3415	70
4. Spalding's	38	2	1	65½	3765	80
5. Seyer's	37	3	4	65	3860	75
6. Smoothy's	36	2	14	64½	3985	65
7. Kent Red	36	2	4	64	3755	65
8. Sewell's	36	0	6	63½	3535	65
9. Piper's Thickset	33	3	0	63½	2550	100
10. Kent Red	36	2	14	64	3780	50

——	Weight of Grain per Acre.	Proportional Weight of Straw in comparison with Grain.	Proportional Measure of Chaff in comparison with Grain.
	lbs.		
1. Colne White Chaff	2654	1·22	2·09
2. Bristol	2520	1·39	1·88
3. Sharp's, Goody's, or Crabb's	2510	1·36	1·78
4. Spalding's	2522	1·49	2·05
5. Seyer's	2458	1·57	1·98
6. Smoothy's	2368	1·26	1·77
7. Kent Red	2340	1·60	1·77
8. Sewell's	2291	1·54	1·80
9. Piper's Thickset	2142	1·19	2·91
10. Kent Red	2350	1·60	1·36

The wheat to which the above tables refer was sown on the 28th of October, 1845, at the rate of 5 pecks per acre, with the exception of No. 10, and that was at the rate of 10 pecks per acre. The reader will of course draw his own conclusions as to the merits of each kind of wheat; and also of thick and thin sowing.

6. *The Treatment of the Crops in Spring as to Pressing and Hoeing.*

Pressing in the spring during dry weather, and before the wheat becomes too forward, is generally productive of good, though especially required on soils that are naturally loose and light in their texture, and on those soils which require draining; for where water saturates the surface soil, it becomes increased in bulk during winter by its conversion into ice in frost, which, of course, raises the soil, and when the frost goes away the plants are partially thrown out. This is accounted for thus:—The frost causes the ground to swell, and, as it rises, the root of course rises with it; when it thaws, the ground shrinks, but the root remains in its elevated position, and, by the action of alternate frosts and thaws, is at last thrown entirely aboveground. This must occur to the greatest extent on soils containing superfluous moisture, though it will occur on any soil, particularly those of a calcareous nature, when frost happens to follow immediately after rain. Therefore, when the soil treads loose in the spring, it is very important to use the heavy roller, or some other means of consolidating the soil. Crosskill's clod-crusher is highly beneficial for this purpose, but can only be used in very dry weather. Treading with sheep is also an effectual way of fastening the roots. On the loose soil of the fens the wheat is trodden by gangs of men and women, each treading along one drill; by this means the soil is consolidated effectually: it is not an expensive operation, and on the loose vegetable soil of the fens is more efficacious than rolling. The feeding off wheat with sheep in the early part of the spring, when likely to run to too much straw, is useful on rich soils. If the land be foul when the seed has been sown broadcast, it must be cleaned by hand-hoeing, but, if drilled or dibbled, the horse-hoe may be successfully used. In many places the practice is to hoe wheat, whether foul or not. As a general rule hoeing should be begun as early in the spring as the weather permits. Harrowing is occasionally found beneficial, particularly when the ground is crusty and the root lies deep in the ground: it has the effect of loosening the surface, and, whether that be done by the hoe or harrow, an improvement will be seen in a few days by the fresh vigour of the plants. Harrowing light sands and gravelly soils obliquely across, or at right angles to the drills, is peculiarly

advantageous, as it destroys the red-weed or poppy, and other annuals that infest light land. For the destruction of the poppy it is recommended to harrow when the soil is slightly crusted with frost.

When, from the extreme luxuriance of the crop in the spring, there appears a probability of its being laid, the process of flagging is resorted to as a preventive. Flagging is executed by means of the bagging-hook or scythe, separating the flag or blade from the stalk. This should be done about May, before the formation of the ear; and in doing it the stalks will require examination, that the ears may not be cut off.

7. *The Diseases to which Wheat is liable.*

The principal disease, and one which can be completely guarded against by the seed undergoing preparation previous to its being sown, is that which is commonly known among farmers by the name of smut.

This disease was formerly very common, but now smut-balls among good farmers are seldom seen; when they are found it may be attributed to carelessness in preparing the seed. Tull informs us that—

"Brining seed-wheat to prevent smut was first practised about the year 1660, when a vessel of wheat was sunk near Bristol, and the grain so much injured by salt water, that, though it would vegetate, it was considered to be unfit for bread. It was taken out of the vessel at low-water, and sown in different parts. It was free from disease at the following harvest, when wheat in general happened to be smutty. This accident led to the practice of brining."

Salt water of sufficient density to float an egg is still extensively used. A quantity of salt and water of the above density is prepared in a tub, the wheat is put into the pickle, and, when stirred, all the diseased or light grains will rise to the surface, which are skimmed off. The wheat is then taken out of the brine, and a sufficient quantity of new slaked lime sifted upon it to dry the whole quantity.

Some farmers wet their seed by throwing over it, when lying in a heap, a quantity of urine; it is then well mixed, and dried with lime, as in the former case.

Water poured on caustic lime, and then thrown on the wheat while effervescing, is a plan adopted by many.

But the cleanest, and perhaps the most efficacious, preparation is that of blue vitriol (sulphate of copper): 4 quarts of boiling water poured on 1 lb. of blue vitrol is sufficient for three bushels of wheat; this is well mixed upon the floor with the grain, and thrown into a heap on the night previous to the day the seed will be wanted.

Others prepare a solution of blue vitriol in a tub, by adding double the quantity of cold water to the above mixture; the wheat is put into it, and the light grains are skimmed off. The seed is then taken out and laid in a heap to dry. A convenient apparatus for wetting wheat, is a tub sufficiently large to wet four bushels at once. The solution is first put in, and then four bushels of wheat; this is well stirred, and skimmed with a common fleeting-dish for ten minutes. The liquor is then drawn from the tub into an under tank, and the wheat thrown out with a shovel. As soon as this is completed the solution is returned to the tub, and we proceed in like manner with another four bushels.

Another method is to have a "skep" basket, into which the wheat is put, and plunged into the solution contained in a tub.

When the seed has been prepared, and cannot be used on account of the weather, care must be taken to spread it thinly over a floor, and give it an occasional turning.

There are many other diseases to which wheat is liable, as the rust, blight, mildew, &c. &c. Some of these are owing to the growth of parasitical plants, "fungi," which arise from a want of the proper constituents in the soil for the growth of the wheat-plant to perfection, from an unfavourable season, or from a feebleness of constitution inherent in the plant. Disease and havoc are also caused by insects. But to describe fully the diseases to which wheat is liable requires the pen of a man who has made that subject his peculiar study, rather than of the farmer: the latter may know from dear-bought experience how to guard, in some measure, against these diseases, but cannot so well describe their cause. Those who are curious on the subject, and wish for further information, will do well to consult the articles by Professor Henslow and Mr. Curtis in the Journal of the Society, also Baxter's 'Library of Agriculture,' 4th edition, and Sir J. Sinclair's 'Code of Agriculture.'

8. *The Time and Mode of Cutting.*

When the grain of red wheat can be squeezed between the thumb and finger without any moisture being forced from it, cutting may always be safely commenced. The sample is never better than when cut in this state: when cut later the wheat is seldom so good in quality; in addition to which, serious loss is sometimes sustained during high winds when it is standing in a riper state. White wheats should stand somewhat longer. With respect to the colour of the straw as a sign of maturity, we may observe that, if in a healthy state, the ear generally ripens before the straw; the yellowness of the chaff and upper part of the straw shows that the crop is fit to cut; and the uniform yellow colour

of the straw shows that the crop has arrived at maturity, and, if standing in the field, is liable to be shaken out by the wind. Those who wish for further information respecting this subject will find an interesting account in Baxter's 'Library of Agriculture,' vol. ii., p. 402, 4th edition.

The methods of cutting are either by mowing, bagging, or reaping. The latter mode leaves a large proportion of straw in the field; a system in many parts superseded by the practice of mowing, and the sooner it is generally superseded the better it will be for those who cultivate the land—reaping being the most expensive mode of harvesting the corn, and the most destructive to the straw, as the stubble generally becomes rotten, and two-thirds of it lost before it can be carted home. "Bagging," which is performed with an instrument known as a bagging-hook, cutting the straw close to the ground, is rather more expeditious than reaping. The cost is 1*s*. per acre less. Reaping wheat, when performed by the piece, is in England chiefly done by the acre; but the Scotch method of reaping at a certain price per stook, or shock (the sheaves being made of a certain size), is preferable where the stubble is required to be left low; for there is an inducement for the reapers to cut as low as possible, as the lower part of the straw, being the largest, fills the sheaf quickest, and another advantage of this method is, that the sheaves are never made too large.

The cheapest and most expeditious way of cutting wheat is by mowing. This is done with a scythe, on which is fixed a high bale for laying the corn in one direction. One method is to cast the swathe towards the standing corn, the other from it. The general plan in those parts where the system is adopted is for the mower to cut enough for a sheaf, after which he returns to gather it, and then ties it up. One man will mow, tie, shock, and rake three roods per day. There is a very obvious loss of time in this method in laying down and picking up the scythe. In other parts of the country the practice is rather different; the best method appears to be as follows:—A company of men, say four, are employed mowing; four strong lads will gather with their hands and bind the wheat as fast as it is cut; and a couple of men, with a boy, can stook the sheaves, rake the stubble, and bind the rakings.

The great advantages of mowing wheat are—

1st. Cheapness and despatch.

2nd. A breadth of wheat can be cut down early in the morning, while the grain is damp, and tied up and shocked without injury in the middle of the day.

3rd. It is allowed that mown wheat is sooner fit to cart, and sustains less injury than reaped in bad weather.

4th. It leaves the land clear for the commencement of tillage.

5th. The securing a greater quantity of straw, and hence the making more manure.

The objections to mowing hold good only on such land as produce very bulky crops. These are—

1st. The loss of gleaning to the poor, which is no valid objection, and only to a certain extent correct.

2nd. The crop is more expensive to carry and thrash.

The extra expense of thrashing mown wheat, by four-horse machines, has been estimated at 2*s.* 6*d.* per 10 quarters; by flail the expense is doubtless considerably increased; and where this method is still in vogue, mowing wheat is rarely practised.

9. *Thrashing and Dressing.*

These operations are, by the majority of enlightened and economical farmers, generally performed with machinery, frequently at a cost of less than one-half what is usually paid for thrashing by hand; the straw left free from grain, the grain sacked in better condition, whilst it is not exposed to so much danger from pilfering. Yet, notwithstanding these advantages, the flail is extensively used, particularly in the southern counties. But it must be admitted that, where the straw is saleable, and is carried to market, it does not make so good a price from the machine as it does from the flail. The best method of dressing is undoubtedly by a well-constructed machine, such as those made by Cooch, Hornsby, and others. Very few farmers, however prejudiced against machinery generally, are now to be found without one for dressing.

Thrashing and dressing during dry weather have a material effect on the sample, restoring a damp sample to better condition, and enhancing its price; whilst, if these operations be performed in wet weather, the wheat, though previously dry, soon handles cold and damp.

Kingswood, Baldock, Herts,
May 20*th,* 1847.

VI.—*On Burning Land for Manure.* By John Peirson.

Burning of earth, or rather clod burning, is now very extensively practised in Suffolk: it is adapted for heavy clay soils, and with most successful results; producing most excellent crops of mangold-wurzel and turnips; barley luxuriantly following, and generally certain of a healthy plant of clover. Wheat grown in the following year after clod burning, shows its advantage by increased production. The manner of doing it is to plough a piece

of land in the spring of the year, or plough back a piece of wheat stubble that has been ploughed once during the autumn, or the first ploughing after tares, or a bean or pea stubble; but there is seldom time in the autumn for this last. I mention ploughing back a wheat stubble, for if previously ploughed and exposed to the frosts of winter, it will become too pulverized for clod burning. Having ploughed it, you roll and harrow in dry weather till the majority of clods are about the size of a large walnut; nothing so good as the clod-crusher to forward this operation: when perfectly dry, collect them into rows about six yards apart, with iron-teethed rakes; take a quarter of a whin faggot, or less, according to size, previously cut into lengths by a man with an axe; place these pieces about 4 yards apart in the rows, cover them with clods, putting the finest mould upon the top of the heap to prevent the fire too quickly escaping; observe the wind, and leave an opening accordingly; having set fire to a long branch of whin, run from opening to opening till two or three rows are lighted, secure these, and then put fire to others: keeping a man or two behind to attend to the fires and earthing up till the quantity desired may be burned, which will generally take four or five hours, say from 25 to 35 loads per acre of 30 bushels per load.

This work is often put out to a gang of men at about 10*s.* per acre for labour, and the whins cost 4*s.* 6*d.* per acre, not including the carting.

When the heaps are cool, spread and plough in. The great advantage of burning clods in these small heaps in preference to a large one, is the saving of expense in collecting and spreading; there is much less red brick earth, and more black and charred; no horses or carts moving on the land whilst burning, and a large field may be all burned in a day or two, therefore less liable to be delayed by wet weather. In the heavy-land part of Suffolk the farmers purchase whins from the light-land occupiers, and often cart them a distance of fourteen or sixteen miles when there is no work pressing on the farm. These are stacked up and secured by thatching with straw, that they may be dry and fit for use when required. Bean straw is the next best fuel to whins or furze, and it is astonishing to see how small a quantity will burn the clods, if they are of the proper size and dry. Observe, if the soil is at all inclined to sand, it will not burn so well. I will here mention, that I often sift and store up a few loads of the best blackened earth to drill with my turnips instead of buying artificial manure, and find it answers remarkably well, and assists in maintaining the position that a heavy-land farm in Suffolk can be farmed in the first-rate style without foreign ingredients.

I know of only one objection raised that requires my notice;

some are of opinion it tends to lessen the quantity of the soil, consequently injures the real staple of the land, and that, however desirable it may be once, it ought not to be repeated. I am not of this opinion, and should say, if repeated at distances of 10 or 12 years, it would make no perceptible difference in the staple of the land. It produces more straw, therefore a larger bulk of manure returned to the soil. I should certainly not recommend it three or four years in succession; besides, the benefit would not be so decided in that case. I do not know that I can better answer these objections, and at the same time show the opinion of the benefits arising from it, than by quoting the report of a farmer's club, of which I am a member, on this subject, arising as it does from a number of practical farmers, residing in the centre of the heavy-land district of Suffolk.

Report. "The general feeling of the meeting was decidedly in favour of clod burning. A calculation was made, that if 25 loads per acre was burned and carried off the field, it would not reduce the soil more than one quarter of an inch: this, however, is not done; the soil when burned, is again restored to the field, although in an altered and more desirable form; by the operation of the fire it is rendered light, friable, porous, and highly absorbent of gaseous matters, and therefore well calculated to improve the texture and fertility of heavy retentive land; it makes it more pervious to both air and water (two grand supporters of vegetable life), it increases the efficiency of the drains by letting the water more freely to them, and being more friable, the land works better and at less expense. It further promotes vegetation by converting into soluble matters available to plants, vegetable remains; which in consequence of the usually wet impervious nature of the soil, have become as it were indigestible and therefore inert and useless: it likewise has the effect of insuring the future benefits of such substances. It was also advocated as being destructive of the roots and seeds of weeds; of insects, their larvæ and eggs; and, as was pretty clearly demonstrated, it enabled land to bear the same crop in quicker succession, by its supposed effects on the exudations left by former crops."

Only one trial in Suffolk has come under my observation of burning clay in a pit. The person who tried the experiment states, that during the dry weather, the clay appeared to burn almost immediately it was broken up from the side of the pit; that he could burn it with only a little wood to begin the heap. The pieces of clay were broken small when thrown on the fire; but a wet day or two following prevented him proceeding with the experiment. He is of opinion coals and wood are too expensive for this work in Suffolk, if a constant supply is requisite to make the clay burn, and with our uncertain climate it would be necessary to have a roofed building to prevent the clay getting wet. That the attraction of burnt clay for ammonia must render this a most useful manure for heavy soils; but at present the expense of preparing

and burning clay, renders further consideration requisite before it could be urged upon agriculturists as a profitable work.

The object, it appears to me, is to burn the earth only to a black or charred state. This can be best performed in small heaps; the continuation of fire in large heaps renders the centre perfectly red, and as hard as a brick. I have read the Report by Walter Long, in the Journal of the Royal Agricultural Society of England, and am pleased with his skill in overcoming this difficulty; but whether the expense of erecting kilns and preparing the clay according to his suggestions is practicable and profitable to the tenant farmer, I have many doubts.

Wishing to promote the objects of the Royal Agricultural Society is my inducement for penning these remarks.

Framlingham, December, 1846.

VII.—*On the Great Level of the Fens, including the Fens of South Lincolnshire.* By John Algernon Clarke.

Prize Report.

The Great Level of the Fens forms one of the most interesting districts in the kingdom, as regards both its past history and its present state. The mists that obscure its ancient condition, the conjectural nature of its early history, and the abundance of curious remains found beneath its surface, afford the highest interest to the antiquary and the man of science; an air of romance is thrown over its early records by the battles of the Saxons against their Norman invaders; while to the engineer and agriculturist the progress and accomplishment of its drainage, and the improvement of its husbandry, present a series of some of the mightiest works that skill and perseverance have ever achieved.

This great level extends itself into the six counties of Cambridge, Lincoln, Huntingdon, Northampton, Suffolk, and Norfolk, being bounded by the high lands of each. It is about 70 miles in length, and varies from 20 to 40 miles in breadth, having an area of more than 680,000 acres. Through this vast extent of flat country there flow six large rivers with their tributary streams, namely, the Ouse, the Cam, the Nene, the Welland, the Glen, and the Witham. These were originally natural channels for conveying the upland waters to the sea; and whenever a heavier downfall of rain than usual occurred, and the swollen springs and rivulets caused these rivers to overflow, they must necessarily have flooded the level to a great extent. This, however, was not the principal cause of the inundation of the Fens;—these rivers were not allowed a free passage to the ocean, being thus made

incapable of carrying off even the ordinary amount of upland water, which would consequently flow over the land. The obstruction was twofold; first, the outfalls became blocked up by the deposits of silt from the sea-waters, which accumulated to an amazing thickness. The well-known instances of boats found, in 1635, eight feet below the bed of Wisbech river, and the smith's forge and tools found at Skirbeck Sluice, near Boston, buried with silt 16 feet deep, show what an astonishing quantity of sediment formerly choked up the mouths of the great rivers. But the chief hindrance caused by the ocean arose from the tide rushing twice every day for a very great distance up these channels, driving back the fresh waters, and overflowing with them; so that the whole level became deluged with deep water, and was in fact one great bay.

In considering the state of this region as it first attracted the enterprise of man to its improvement, we are to conceive a vast wild morass, with only small detached portions of cultivated soil, or islands, raised above the general inundation;—a most desolate picture, when contrasted with its present state of matchless fertility. The first attempt to reclaim the Fens from the dominion of the flood was most probably made by the Romans after the subjugation of the Britons; and many monuments remain of the mighty works they effected,—their banks for repelling the invasion of the sea, and their drains for carrying off the Fen waters. One of the most remarkable of their works is the "long causey," mentioned by Dugdale, "made of gravel, of about 3 feet in thickness and 60 feet broad, (now covered with moor, in some places 3, in others 5 feet thick,) which extends itself from Denver in Norfolk through Grandford, Eldernell, and Eastrea Fen, to Peterborough, 24 miles."* It appears that Holland in Lincolnshire, containing about 100,000 acres, and Marshland in Norfolk, of 30,000 acres, were reclaimed from the sea by the Romans. So great was the amount of silt deposited from the tidal waters at the mouth of this great bay, that it increased to such a height as to check the "ordinary flow of the watery element, and got ground," says Dugdale, "so fast upon the ocean, that those active and industrious people, the Romans, finding the soil thus raised to be much more rich and fertile than any upland ground, raised strong banks of earth on that side towards the ocean, to defend it

* A cutting that was made across this road at Eldernell shows the permanent manner in which the Romans did their work; it is laid upon the Moor, the first layer upon it being oak branches, then a considerable thickness of the Northamptonshire rough flag-stone, and then alternate layers of gravel with a small layer of clay; which, together, have formed a cement that nothing but the unwearied application of the pick can remove.

from the overflowing of the spring-tides." But whatever progress might have been made in the work of draining by the Romans, the Fens were in as deplorable a state as ever at the Norman conquest. During the government of the Saxons many religious houses had been erected,—amongst others, the famous abbeys of Crowland, Thorney, Ramsey, Spinney, and Ely. The islands upon which these buildings were situated are described as being exceedingly fruitful in corn, abounding with all sorts of trees, environed with alders, reeds, green canes, and rushes; being full of fair gardens and fat pastures, shady groves and rich meadows; abounding with innumerable stores of fish and fowl, together with harts, goats, and hares; so that there was abundant employment for hunters, fishermen, and fowlers. But these fruitful spots were but small patches amidst the deep and vast fens,—the access to many of them being only by boats,—and the whole level may be regarded as an immense lake and bog, the habitation of rude husbandmen, and the resort of robbers and marauders, until the reign of King Stephen. It must not be forgotten, however, that considerable improvements were made in that part of the level called Deeping Fen. Richard de Rulos, Chamberlain to William the Conqueror, converted a great part of the common fen adjacent to Bourn and Deeping into "*several,*" for meadows and pastures. He inclosed all his lands extending from Deeping to the Roman Carr-dike, "excluding the river of Weland with a mighty bank; because every year almost all his meadows lying near unto that stream were overflowed with the continual inundation thereof; and erecting upon that bank divers tenements and cottages, did in a short time make it a large town, whereunto he assigned gardens and arable fields; and, by thus banking the said river, reduced those low grounds, which were before that time deep lakes and unpassable fens, into most fruitful fields and pastures, and the most humid and moorish parts thereof to a garden of pleasure."

An author, in the reign of Stephen, A.D. 1135, describes the Fens as a very agreeable country to the eye, adorned with many woods and islands. Another writer, in the time of Henry II., A.D. 1154, speaks of the country around Thorney as "a very paradise in pleasure and delight,—it resembles heaven itself;"—"it abounds in lofty trees, neither is there *any waste place* in it; for in some parts there are apple-trees, in others vines, which either spread upon the grounds or run along poles." The Fens at this time, therefore, may have been in a more flourishing condition; at least a far greater portion of the level than consisted of the islands before mentioned may have been under cultivation; but at all events the country soon after resumed its original wild and unprofitable aspect.

The description, then, which has been given will suffice to indicate the general state of the Great Level previous to the great works of drainage, and will also give some idea of the magnitude and difficulties of that undertaking, which the enterprise and industry of man have so successfully accomplished.

The first great work was executed by Moreton, Bishop of Ely, in the reign of Henry VII., A.D. 1478. He made a cut, forty feet wide and four deep, from Peterborough to Guyhirn and Wisbech, and also, as is reported, a new outfall to sea. This cut was of great importance to drainage and navigation, and still continues so at the present day,—the cut from Guyhirn to Wisbech still bearing the name of "Moreton's Leam." The only improvements, however, that were made prior to the reign of Charles I. appear to have been local, and comparatively unimportant. In the reign of Elizabeth the general drainage of the Great Level began to be considered as a public concern, and frequent protests were made to the Government against the deplorable condition of this district, which was then, as it had been "for the space of many ages, a vast and deep fen, affording little benefit to the realm other than fish or fowl, with overmuch harbour to a rude and almost barbarous sort of lazy and beggarly people." Accordingly a plan was set on foot for draining the whole level; but nothing of practical benefit was effected beyond the issuing of courts of sewers, the surveying of the district, and the passing of the first law for draining the Great Level in A.D. 1600, until the accession of James I. On the 22nd of June, 1606, was passed the first local act for improving the state of the Fens. Under this act 6000 acres, called "the ring of Waldersea and Coldham," in the Isle of Ely, were drained, the adventurers in the undertaking receiving two-thirds of the lands as a recompense. In 1630, the illustrious Francis, Earl of Bedford, with 13 gentlemen adventurers, undertook to drain the level, on the condition that they should have 95,000 acres for their satisfaction. In order to carry off the superfluous waters, the Earl and his associates caused the following channels to be made, namely:—

1. Bedford River (now called the Old Bedford River), extending from Earith to Salter's Lode, 70 feet wide, and 21 miles in length.
2. Sam's Cut, from Feltwell, in Norfolk, to the river Ouse.
3. A Cut near Ely (now called Sandy's, or Sandall's Cut), 2 miles long, and 40 feet wide.
4. Bevill's Leam, from Whittlesey Mere to Guyhirn, about 10 miles long, and 40 feet wide.
5. Moreton's Leam, before mentioned, was *new* made.
6. Peakirk Drain, 10 miles long, and 17 feet broad.
7. New South Eau, from Crowland to Clow's-cross.

8. Hill's Cut, near Peterborough, about 2 miles in length, and 50 feet in breadth.
9. Shire-Drain, from Clow's-cross to Tyd, and thence to the sea.

Besides these cuts and drains, they erected a great number of sluices, for the purposes of holding the tides out of the rivers and drains, and for keeping out the land-floods, &c. During the Commonwealth the work proceeded under the conduct of William, first Duke of Bedford, son of Earl Francis, united with a new company of participants and adventurers. The famous Sir Cornelius Vermuyden, a Zealander,—who had been engaged in draining the Low Countries, and in draining and improving Hatfield Chase, in Yorkshire,—was employed by this company as director of the works. He had partitioned that part of the level lying principally in Cambridgeshire into three divisions, called the North, Middle, and South Levels,—by which names they are distinguished and known at the present day,—each of these levels having its particular rivers, banks, works of drainage, and outfalls to sea; and the three taken together comprise what is now called the "Bedford Level," a tract of upwards of 310,000 acres. A sufficient description of their situations in the Great Level will be afforded by saying that the former drains by the Nene, having its outlet below Wisbech; the two latter empty themselves by the Ouse, having its outfall at Lynn. The banks of the Welland, breaking on the north side, overflows Deeping Fen; on the other, the North Level. The banks of the Nene giving way, deluges on one side the North, on the other the Middle Level; and if the banks which confine the Ouse break on one side, they lay the Middle Level under water, and on the other the South Level. The exertions of this company were first directed to the drainage of the North Level, *i. e.* the lands lying between the Welland river and Morton's Leam. They defended the Welland by a bank, 70 feet broad at the bottom, and 8 feet in height. The waters of the Nene, descending from Northamptonshire, were also restrained by a similar bank, extending from Peterborough to Guyhirn. The natural drains were scoured out and opened; and a new river, now called "Smith's Leam," was made as a continuation of Hill's-Cut (made by the former Earl); thus improving the navigation from Wisbech to Peterborough. The company also defended the Middle Level from the overflowing of the Northamptonshire waters (a sluice having been previously erected at Standground, near Peterborough) by a large bank from Standground to Guyhirn, where it unites with the great Waldersea bank. The waters of the Ouse were restrained by a great bank, extending from the high lands of Over, in Cambridgeshire, to the Hermitage, near Earith, where a navigable

sasse (or sluice) was erected, to turn the upland floods out of their natural channel, by Ely, into a new river called the "New Bedford," or "One Hundred Feet River" (parallel with the old Bedford river, cut by Earl Francis), commencing a short distance below the great bridge over the old river Ouse, near the Hermitage, and running thence in a nearly straight line to the great sluice at Denver in Norfolk. The earth coming out of this river was laid on the south side, forming a bank 60 feet wide at bottom, 10 at top, and 8 feet high, for the protection of the South Level. Another great bank was also made on the north side of the Old Bedford River, thus leaving a large space of land between the two banks liable to be overflowed by the two rivers. This long strip of land, containing upwards of 5000 acres, called "The Washes," is used as a reservoir for the winter floods. The company also cut or completed several artificial rivers, viz. Vermuyden's Eau, or "The Forty-feet Drain," from Welch's Dam on the Old Bedford, to the river Nene near Ramsey; Thurlow's Drain, or "The Sixteen-feet River," extending from the Forty-feet to Popham's Eau; Hammond's Eau, near Somersham; Stonea Drain, near March; Moore's Drain, or "The Twenty-feet River," in the parish of March; and Conquest Lode, leading to Whittlesey Mere, and dividing the parishes of Yaxley and Farcet, in Northamptonshire. They also cut a new river, called "The Tongs Drain, or Marshland Cut," sluices being placed at both ends of the drain. Considerable improvements were made in Whittlesey Dike, Popham's Eau, and the old river Nene. Denver Sluice was also erected, to turn the tidal waters into the Hundred-feet River, as well as to prevent the upland floods reverting up the Ouse, or "Ten-mile River," towards Littleport. Some trifling embankments only were made (besides the great barrier bank of the "Hundred-feet," already mentioned) for the protection of the South Level against the upland waters descending by the Cam, and also the Mildenhall, Brandon, and Stoke rivers. The greatest work intended for the benefit of this level was the cutting of a large river, called "Downham," or "St. John's Eau," of 120 feet wide and 10 feet deep, extending from Denver Sluice to Stow Bridge (nearly 5 miles), for the conveying away with greater facility the flood waters descending from the several rivers within the South Level. Sluices were erected at both ends of this river; numerous other sluices and dams were also made, and many small drains, such as Grunty Fen Drain, near Streatham, and others; Reach, Swaffham, and Bottisham Lodes were scoured out, straightened; and most of the works begun by Francis, Earl of Bedford, completed.

Thus the face of the new country began to assume the appearance of fertility and agricultural prosperity; and Vermuyden states

that the North and Middle Levels were so far improved in 1652, —the South Level not yet being sufficiently drained,—that there were "about 40,000 acres then sown with coleseed, wheat, and other winter grain, besides innumerable quantities of sheep, cattle, and other stock, where never had been any before."

Improvements were also made in the fens of Lincolnshire; the first *attempt* being to drain Deeping Fen—a large tract extending between Spalding and Deeping, bounded on the south and east by the Welland, and on the north by the Glen, and part of the district between this and the sea, called South Holland. In Charles I.'s reign a company of adventurers undertook the work. They caused the river Welland, from Waldram Hall (near St. James's, Deeping) to Spalding, and thence to the outfall, to be made wider and deeper; the drain called "the Staker Drain," about 20 feet in breadth, to ease the river Glen; together with Hill's Drain and Vernat's Drain, they likewise made new; and perfected Exeter Drain from Cowbit Tunnel almost to the sea. Near Spalding they also erected a great sluice, &c., by which works the water was so well taken off that in summer this whole fen yielded great store of grass and hay; and had been made winter-ground in a short time, but for "the unseasonableness of the times, and riotous letts and disturbances of lewd people," so that the banks and sewers being neglected by the adventurers, it became again overflowed.

Northwards of Deeping Fen is a long narrow reach of fen-land skirting the high lands, and extending from the glen to Kyme Eau; being about 15 miles long, and varying from 2 to 5 miles in breadth. In the time of Charles I., Robert, Earl of Lindsey, Lord-High-Chamberlain of England, became the undertaker for the work of draining this district, which was then called "Lindsey Level." He undertook to drain the whole 35,000 acres, accepting 24,000 acres as a recompense; and after effectually draining it at a cost of 45,000*l.*, the Earl and his participants "did inclose, build, inhabit, plant, plow, sow, and reap two years without disturbance; but the third year, in contempt of the orders of parliament, the country-people entered and destroyed the drains and buildings, as also the crops then ready to be reaped;" so that it again became reduced to its former wet and uncultivated condition.

North-eastward of this district, lying towards Wainfleet, and bounded on the north by the Wolds—from Tattershall towards the sea—on the south and west by the river Witham, and on the east by a tract of rich land extending from Wainfleet to Boston—is a large tract of land called the "East," "West," and "Wildmore" Fens. These fens, containing about 40,000 acres, were also drained, inclosed, and cultivated by adventurers in the time

of Charles I. It is probable that the undertakers and the king, to whom a share was allotted, had taken to themselves a larger portion of the fen than the country thought just and reasonable; for in the time of the great rebellion, a large mob, under pretence of playing at football, levelled the whole of the inclosures, burnt the corn and houses, destroyed the cattle, and killed many of those who occupied the land. They proceeded to destroy the works of drainage, so that the country was again inundated as it had formerly been. After the Restoration, however, the adventurers repaired their works, resumed their lots of property, and began again to cultivate them.

Between the fens once called "Lindsey Level" and Wildmore Fen, extending towards Boston and Swineshead, is "Holland Fen," a district containing 22,000 acres. This was called "the Eight-hundred Fen;" "but anciently," says Dugdale, "Haut-Huntre Fen." The drainage was undertaken by King Charles I., a tax of 20*s.* per acre being laid upon 16,000 acres, to be levied upon the inhabitants of Braytoft, Swineshead, Wigtoft, Soutterby, Alderchurch, Fosse-Dike, Kirton, Frampton, Wiverton, Hole, Dockdike, and Boston, claiming common therein. But this tax not being paid, the king was declared sole undertaker, having for his recompense 8000 acres; and though several great drains were cut, the fen still remained an uncultivated waste.

It will be seen that the whole of the Fens were thus intersected with drains for carrying off the waters, and that by far the greatest progress had been made in the drainage of that part of the fens called "the Bedford Level." In the reign of Charles II. the "Bedford Level Corporation" was founded by statute, for the continuance and preservation of the works of drainage in this great district, and consists of one governor (the Duke of Bedford), six bailiffs, and twenty conservators annually chosen, who have ever since conducted the affairs of the Level. No attention was paid by the corporation to the improvement of the great outfalls to sea, which still remained choked by the deposits of silt and sand, so that the drainage was as yet very imperfect. In fact, the Level became so inundated by the choking up of the internal drains, the defective state of the rivers themselves, and the neglect of the outfalls, that an artificial system of interior drainage was found necessary. This was done by means of wind-engines, which raised the water from the interior drains to the level of the main rivers. Early in the reign of George I. an act was passed for draining a private district within the Bedford Level, called "Haddenham Level," being the *first* private district in the Bedford Level drained by mills, a plan which has since been brought into the most extensive operation. Numerous districts followed the example; each being embanked all around to exclude neigh-

bouring floods, ditches made to empty themselves into a "mill-drain" terminating near a river, and upon the bank of this a windmill erected, which by means of a water-wheel dashed the water out of the mill-drain up an ascending curve into the river. This system, however, proved a remedy only to some districts at the expense of others; the general evil at the outfalls was unremoved, and as the inclosures on the high lands multiplied, floods became more frequent and destructive. In A.D. 1770 a breach of the Nene Bank inundated the North Level, laying the whole 7 or 8 feet deep under water; the breach of banks in 1795 inundated 25,000 acres, from Denver to Ely, much of it 6 feet deep, and flooded altogether no less than 141,000 acres; and nearly as much in the floods of 1799, which were the result of having an insufficient outfall, the burden of water from the better-drained uplands, and full 500 mills at work emptying into the rivers. In 1721 the attention of the Bedford Level Corporation was directed to the imperfect state of the river Nene below Wisbech, and a new cut (now called "Kinderley's Cut") was ordered to be made, for the purpose of turning the channel of the river under the Shire Drain Sluice, and keeping it confined within a narrower channel. It was to be 2 miles in length, to begin at the river's end about 4 or 5 miles below Wisbech; and it was also intended to carry the river, in a confined channel 2 miles further, to a place named Peter's Point, where there was a fall of 5 feet 7 inches. This cut was not quite completed until the year 1773, when, under the Tydd and Newton Drainage Act, the work was performed, and it was found that this improvement tended essentially to the security of the south bank of Moreton's Leam, which is the great protection of the Middle Level. In the year 1751 Kinderley proposed a plan, worthy of a real genius, for improving the drainage of the Fens and the navigation of the great estuary called "the Wash." He designed to convey the waters of the Ouse and Nene into the centre of the estuary, there to unite with the Welland and the Witham, the consequence of which would have been, first, avoiding all the shifting sands of the Wash; and, secondly, draining so much of it as would amount to more land than the whole county of Rutland. Every one of his cuts was proposed on the same principle that has governed all the later improvements, that of "avoiding broad channels with shifting sand-banks, and confining the rivers to *narrow* channels in order to ensure *depth* by force and weight of current." This noble idea was never executed, and little was done for improving the outfalls until near the commencement of the present century, the Fens lying, in the interval, in a most deplorable state. In the year 1762 the "Witham Drainage Act" was passed. The river Witham had been formerly navigable up to Lincoln; but the

outfall was at this time (as it had been for many years) greatly obstructed by deposits of sand and silt, and the low lands and fens lying on both sides—containing upwards of 100,000 acres—were frequently overflowed. By this act this vast tract of waste land was to be drained, and a new river was cut, 11 miles in length, the water being held up by a great sluice erected at Boston, so that cargoes are conveyed from Lincoln to London or other ports in the same vessels. The expense of making this cut, which formed a straight channel in place of the former most circuitous river, was defrayed by taxes levied upon six districts, comprising more than 112,000 acres, supposed to be benefited by the work. In 1794 an act was passed for improving the outfall of the river Welland, and better draining the low grounds and discharging their waters into the sea. A new canal or channel was made from the reservoir, below Spalding, to Fossdike; an embankment was subsequently made inclosing Fossdike Wash, and a bridge constructed over the improved channel. The work of carrying this channel, in a straight course, into the sea is still in progress, and will be noticed further on.

In 1795, after a hard struggle, the Eau Brink Act passed, for giving a new outfall to the waters of the Ouse, between St. Germain's Bridge and Lynn; but the work was not commenced for some years, as the requisite money could not be procured. In 1818 the work was begun, Telford and Rennie being engineers, and Sir Edward Banks the contractor. The cut, which is two miles and a half long, was finished in 1821, but was subsequently widened in 1826, a bridge being erected over it at Lynn.

In the year 1827 an act was passed for improving the outfall of the river Nene, from Kinderley's Cut (before mentioned) to Crab's Hole, and for embanking the salt-marshes and bare sands lying between that cut and the sea. This great undertaking was completed in 1831, under the superintendence of Telford and Rennie, and contracted for by Joliffe and Banks. The new course from Kinderley's Cut to the outfall at Crab's Hole is 6 miles in length; and a new cut, called the North Level Drain, was also made from Clow's Cross to Gunthorpe Sluice in place of the old Shire Drain; besides which, a bridge was erected at Cross Keys (or Sutton Wash), and an embankment made across the Salt Marshes; forming a high road, which, with the bridges previously erected at Fossdike and Lynn, connects the northern and eastern parts of the country.

Having thus attempted a brief sketch of the original condition of the Fens, the progressive works of drainage which have been executed, and the recent general improvements in the outfalls, it will be necessary to notice each large district separately, in order

to afford a clearer view of the present state of the drainage and agriculture.

The extent and boundaries of this great tract of flat country have been already described, and a few remarks may be now made respecting the nature and properties of the soil. The soil of the fens in general consists of a deep deposit of peat or "moor" resting upon the Oxford clunch or fen clay formation. This deposit is a vegetable substance in a *partial* state of decay, being a congeries of the roots and fibres of about forty different species of plants, mixed with earthy matter, and holding water in excess by capillary attraction. This crust is of varying thickness, in some places being several yards in depth, in others only a few inches. The surface, however, is generally found to be mixed with silt or other soil, and by tillage, cultivation, and the influence of the atmosphere this upper part of the moor has become still more decomposed, forming a black earth, between which and the clay occurs a stratum of the original peat. This subsoil is generally a brown, spongy substance called "turf" or "moor," which is dug and dried for fuel; after being thus dried, it will expand enormously when placed in water. This pervades nearly the whole of the peat district, but by good drainage and cultivation it is now, as the fen-men say, fast "wearing out." On the higher and better-drained lands this turf has become, by compression, quite hard, losing its absorbing power, and being incapable of expansion; in which state, sometimes mixed with sand, it obtains the name of "clunch," or "bear's muck," according as it is more or less tenacious. Though the peat principally rests upon a thick stratum of blue calcareous clay called "gault," yet in many parts beds of gravel varying in thickness are found between the peat and the clay, and in some places the bottom-soil is silt. The materials which compose the peat-soil contain the tannin principle in a considerable degree, which has the power of preserving animal and other substances for a great length of time; and oxide of iron is also dispersed through the whole mass. In consequence of this antiseptic property innumerable relics of the ancient state of this country and its inhabitants are found. Large trees, in a perfectly sound state, are discovered between the peat and the clay; firs measuring 30 yards in length, and oaks 6 feet in circumference; fir-apples, hazel-nuts, acorns, and grains of wheat. The horns of red deer, bones, skeletons, coins, weapons, implements, boats, ornaments, and human bodies have been found in various parts of the Fens in a remarkable state of preservation. All sorts of trees are found buried in the higher lands, but mostly oaks; in the lower parts they are usually firs. Immense quantities of shells, plants, &c. are found; roots standing firmly

in the clay with gigantic fallen trunks beside them, all covered by the moor; thus affording some criterion of the sites and magnitude of the forests which clothed this region before that stupendous catastrophe occurred by which they were cast down and overflowed by the waters; their leaves and branches decaying, to form a protective covering over the huge trunks.

In some places a second bed of peat, with plants, &c., still decaying, is found beneath 10 or 12 feet of clay, thus showing the former surface of the earth, with a stratum the deposition of ages resting upon it.* The tract of peat land extends from near Cambridge, through Ely, March, Thorney, Crowland, Spalding, and Tattershall, to Lincoln; in length being about 80 miles, and varying greatly in breadth, though the average may be about 10 miles. The greatest breadths are those from Ramsey to Downham, 24 miles; from Peterborough to Wisbech, 18 miles; and from Bourn to Spalding, 9 miles. But this black fen land is not continuous, being intercepted by alluvial soil deposited by the rivers which pass through it; and towards the surrounding hills and in many other parts, broken by high lands (which were doubtless the fruitful islands that once adorned the Fens) consisting of diluvial deposits of sand, gravel, and clay, either separate or mixed. Between this peat land and the sea is a level tract of rich loam and salt marsh, extending from Lynn through Long Sutton, Fossdike, and Boston, to Wainfleet, being in length about 45 miles, and varying from 4 to 15 miles in breadth.

The peat soil naturally produces a coarse grass not of much value, and abundance of straw when under arable culture, but very little grain, and that of a weak light nature. The land is so porous and spongy, that it holds a great quantity of water, rendering it (when badly drained) so wet and soft that it is impossible to walk upon it; but, when well drained, it naturally sinks down and becomes more firm; and it is of the utmost importance to keep the water as low as possible, such being the absorptive power of the soil that it is always saturated with mois-

* There can be little doubt that the clay found throughout all the fens is a tidal deposit, probably washed down, originally, from the uplands into the estuary, and by the tides taken up the rivers and creeks, which, overflowing the whole surface, deposited this stratum of soil, for sea-shells have been found in it even at the depth of 140 feet; and in the operation of claying the old channels of creeks, &c. are found, with numbers of sea-shells buried in the earth, the sides of the creeks being raw silt for 2 feet above the clay on each side. The same *buttery* clay may be found above a stratum of moor, which must be of great antiquity, as the bed (of moor found 2 feet thick in making Eau Brink Cut) must have been a long period, in forming from either a crowded field of vegetation, or a stagnant morass; and after it was formed the tides deposited 6 or 8 feet of clay, on which (as shown in the Eau Brink Cut) the Romans made their embankments.

ture a long way above the water level; and this excessive moisture is injurious not merely from its quantity, but pernicious in consequence of its noxious, astringent, irony, and corrosive qualities; the roots of the plants suffer from this turf-water extremely, causing them to turn yellow and sickly. Formerly the practice of paring and burning was depended upon as the only means of obtaining produce from the arable land; the common method of farming having been to pare and burn for coleseed (or rape), fed off with sheep; after that, three or four crops of oats in succession, and the land was then laid down with grass-seeds for six or seven years. It was then pared and burnt again for coleseed, &c., the produce of the oats rarely exceeding 4 or 5 qrs. per acre.

During the last twenty years an entirely new system of fen-farming has been introduced and brought into universal operation, that is—the clay is lifted up and mixed with the surface-soil. About the beginning of the present century Arthur Young thus writes:—"In digging wells at Wimpole, Lord Hardwicke penetrates 140 feet of what, in Cambridgeshire, is called *gault*, that is, a pale blue clay, seemingly free from sand, and consisting of impalpable particles. Some of it being used to level the gardens allotted to cottagers, and also spread on grass land, it was found to have considerable fertilizing qualities. As there is a *prejudice against deep-ploughing, lest any of this substance should be touched,* it is of some consequence to ascertain the fact. His Lordship's bailiff, Mr. Patterson, from Lothian, is a friend to deep tillage, and has yet found *no evil* to result from gault. Shells are sometimes found in it, even at the depth of 140 feet." The farmers were actually afraid of that substance which time and experience have shown to be an invaluable treasure. After this alterative has been applied to the peat soil, which by itself is of little value for arable culture, it forms the most productive of all soils, yielding the most luxuriant crops of wheat, oats, coleseed, and turnips; but whenever clayed land becomes wet, the greatest injury is sustained, and in that state is often less productive than the moor without clay. The peat soil itself possesses the requisite fertility and productiveness, but cannot fully exert and preserve those powers and display its capabilities until it derives greater consistency and solidity from the admixture of a heavier and more tenacious substance, which thus prevents a too rapid evaporation of moisture by the sun, &c.

The operation of "claying" is performed in the following manner:—Trenches are made about 10 or 12 yards apart, parallel to each other, across a field, and varying in width according to the depth of the clay and the quantity requisite to be taken out, but generally from 3 to 4 feet. The workman commences at one end by digging a hole as wide as the intended trench, and about

6 or 8 feet long, when he arrives at the clay, which is found at 2, 6, or even 10 feet from the surface, he throws it out, half on each side the pit, taking out 2 "*draws*" (or 2 feet) deep: and when a larger quantity is required, 3 draws. Another portion of black soil is taken off in the line of the trench, and thrown into the hole already made; another bottom of clay is then thrown up, and the work proceeds in this way until the whole is finished, the clay being spread evenly over the whole surface except where the trenches are. When the clay is at a great depth "pits" are made (*i. e.* holes) instead of trenches. Such has been the progress of improvement, that the introduction of steam-drainage and the adoption of claying have so condensed and consolidated the land, as to render the practice of paring and burning nearly obsolete; the Fens having now been retrieved from the designation of a swampy unfruitful plain, to be known as one of (if not altogether so) the richest and most fertile districts in the kingdom.

Bedford Level.

South Level.—In noticing the different divisions of the Fens, it may perhaps be as well to begin at the south of the Bedford Level, and so advert to each whilst travelling towards the north. The first, then, is that portion of the Bedford Level termed the "South Level," containing about 120,000 acres, south of the old Bedford River, which runs for 21 miles in a straight line from Earith, in Huntingdonshire, to Salter's-lode sluice, near Downham, in Norfolk. The *whole* of the districts into which this level has been subdivided have now (or will *shortly* have) a *steam* drainage, though many wind-engines still remain standing, to throw out a little of the water as long as they can work without repairs; and these will not be left long, for almost every time the Commissioners meet, orders are given for pulling down another mill.

Over Fen has an engine of 20-horse power, which throws its water into the "West River," or Old Ouse. Cottenham Fen has two engines, one of 40, the other 30-horse power, draining from 3000 to 4000 acres. Haddenham Fen has a 60-horse engine which drains 7000 acres. Stretham Fen, about 7000 acres, is drained by one 60-horse engine, and all the above throw into the Ouse. Thetford Fen, about 1000 acres, is drained by a 15-horse engine; and Burwell Fen, about 4000 acres, by a 30-horse power engine, throwing into the Cam and Ouze. Swaffham Fen has an engine of 30-horse power, throwing into the Cam. Middle Fen has a 60-horse engine on the bank of the Lark River, draining about 14,000 acres; and Burnt Fen, 2 engines of 40-horse each, which drain about 14,000 acres, one throwing into the Lark, the other into the "Brandon River," or Lesser Ouse. Mildenhall Fen is drained by a 60-horse engine, throwing into the Lark river; Lakenheath Fen by a 40-horse engine, which throws into the Brandon

River; Feltwell Fen, by a 30-horse engine, also on the bank of the Brandon River; Southery Fen, by a 60-horse engine, draining 7000 acres of fen and a large quantity of highland water, throwing into the Ouze; and "Littleport and Downham" district, by 2 engines each of 80-horse power, one on the bank of the "hundred feet," the other on the Ouse, or "Ten-miles River," together draining about 30,000 acres, besides which there is a private engine near Denver. The soil of this Level is generally peat, with a subsoil of blue clay: some of it is soft and "buttery," other parts of a harder texture; underneath 4 or 5 feet of peat-soil and moor. Over Fen has a surface of loamy clay on moor, with a gravelly stratum beneath, and productive land. Cottenham Fen is generally a strong fen land mixed with brown clay, on a subsoil of moor and gravel; and Haddenham Fen is of a similar kind, resting upon gravel; but both are productive land. Stretham Fen is principally moor, of several feet in depth, upon gravel. Thetford Fen is strong, useful, good land, from highland warp deposited by continual floods, and is but recently drained. Burwell Fen has a surface of weak black soil, some parts on clay from 3 to 5 feet from the surface, others too deep to be obtained for some years. This fen was drowned for years by highland waters from chalk soils which brought no deposit; the previously named fens were formerly drowned by flood from the clay soils, which brought down a large portion of soil and deposited upon the fen lands. Swaffham Fen has been drained about 27 years by steam; the surface is a light moor, but it is now getting so reduced as to allow of claying. Middle Fen (near Ely) has a different soil, the upper part being a mixture of clay and moor, the lower part moor upon clay. The soil of Burnt Fen is moor resting principally upon clay, which has been and is still being applied to the surface. The surface of Mildenhall Fen is black soil with sand under the moor, generally at 6 or 8 feet depth, and but a small portion of clay; it has been recently drained by steam. The moor in Lakenheath Fen is very deep, with sand generally under it; it has been drained by steam power about 3 years. In Feltwell Fen the clay and sand are too deep to be obtained for some years, and the surface black, but very light because not well drained, having a great deal of highland water running down upon it, bad drains, and an insufficient engine. Southery Fen is peat, with clay generally underneath it, and in many parts claying has become general. Littleport Fen, between the Hundred-feet and Ouse, was formerly badly drained by 75 windmills, but there are now two 80-horse engines, one of which raises about 40,000 gallons per minute, lifting it about 12 feet high. There are 26,000 acres of land taxable to the Drainage Works, and about 4,000 acres of extra skirt land, taxable only to the outer works, besides which it has upwards of 30 miles of catchwater-drains, which take the highland waters into the great rivers.

Before these catchwater drains were constructed, the water from 12,000 acres of high land flowed into the district, and inundated it before the engines could throw it out. The soil is peat-earth and silt-land, made by the Old Croft river and branches from it; in some parts it is marl, which of itself is a

poor soil much acted upon by the frost, but both this and the black land are now extensively clayed, and are very productive; the depth of the moor varies from 2 to 8 feet, and is of good quality.

Much of the soil which has a subsoil of sand (having thus no valuable substance which could be incorporated with and give it strength) yet remains in a wild state, growing very weak crops. Clay has been carted on to it from adjoining lands with great success, but only in scanty instances, though it is certain that wherever clay is applied to the peat it will answer. The general aspect of the country, before drainage made much progress, was a region of reed and sedge; a large portion of Littleport Fen having been let at 1*s.* per acre, into which stock was turned amongst the reed and "turf-bass," and not seen for days together. In winter the country was under water, and fishing and fowling the employment of the inhabitants, who on a few dry spots raised an acre or so of spring wheat for each family. After this succeeded partial drainage, the inhabitants keeping dairies and growing a few oats; but now the country teems with the produce of corn, seeds, and coleseed.

A fine tract of high land, being a diluvial deposit principally of clay, rises in the centre of the South Level, running from Littleport to Ely. From thence the same ridge continues westward through Thetford, Stretham, and Wilburton, approaching the western boundary of the Fens; it then advances northward to Haddenham and Sutton, and returns again by Witcham, Wentworth, and Witchford, to Ely, encircling a basin of black land called "Grunty Fen." This fen, consisting of 1280 acres, would make excellent arable land, but in consequence of its being common to seven bordering parishes, the inhabitants of each place turning in cattle or sheep without any restriction as to numbers, it is likely to continue uninclosed, uncultivated, and unimproved. There is a considerable tract yet unclayed; the principal part has been done *once,* and some portions *twice.*

A large quantity of underdraining has been done on the high grounds, both with tiles and pipes, which are becoming general, and with turf. "Turf-draining" is done by depositing sods of dried turf (or "moor") in deep narrow-bottomed drains, so as to form a wedge with the hollow drain beneath; the "turfs" expanding with the moisture, form a compact and durable mass, preserving open a good and effectual passage for the waters. On the heavy land between Mepal and Ely, in the parishes above mentioned, there are some good pastures, but the principal portion is arable, the fields bounded by neat quick-fences, a large breadth being new inclosures. Barley, wheat, and beans are the principal crops: seeds not being very extensively grown, and oats rarely

sown except for convenience. The land is too heavy for turnips, and will not produce good coleseed, so that the system of "dead"-fallowing is necessarily adopted. Consequently, very few sheep indeed are wintered; perhaps only 3 or 4 acres of turnips being grown on a large occupation of 300 or 400 acres. Leicesters and Long-wools are bought in spring to eat off the grass and the few seeds which may be sown, and sold in autumn. A great number of beasts are kept during the winter upon hay, straw, and oilcake, being sold in the spring as "stores." Little under-draining has been done on the low lands, but in most districts the steam-engines can keep the water low enough to make an outfall for the drains. The prevailing opinion of fen-farmers is, that the peat-soil is so porous as to require little or no under-drainage, and accordingly they are satisfied with cutting one or two drains in a field and partially refilling them with wood or thorns. But a good tile-drainage is very much needed to dry the peat and provide a quicker passage for the downfall water, the principal difficulty being that the peat has a tendency to insinuate between the joints of the tiles, and the drain, lying on a dead level, is liable to be choked by accumulations of sediment. This, however, has been greatly obviated by the use of pipes with "collars," that is, rings of the same material which cover the crevices between the pipes, each collar containing about 2 inches of each adjoining pipe. There is no regular system of low-land management pursued; indeed, so much depends on the proper admixture of the soils and subsoils, and the well making of the manure, and use of artificial manures, that it would be injustice to a good enterprising tenant to restrict his routine of cropping, and difficult to prevent a bad one from injuring the land.

The principal crops are wheat and oats, the alternate crops being varied by beans, seeds, and fallow both for coleseed and turnips. Coleseed is the chief green crop, and perhaps the following five-field course may be more general than others:—1st, coleseed; 2nd, oats; 3rd, wheat; 4th, beans or seeds; 5th, wheat; or perhaps the following six-field course:—1st, coleseed; 2nd, wheat; 3rd, oats; 4th, wheat; 5th, seeds; 6th, wheat.

A great deal of artificial manure is used in this Level; bones for the green crop invariably, guano as a top dressing for wheat, beans, &c., and abundance of linseed-cake in the farm-yards. The sheep grazed in the neighbourhood of Ely, and in Littleport Fen, are Leicesters; sometimes Long-wools and the half-bred Down and Leicesters are bought, but Leicesters are most general throughout the level. Along the whole of the northern boundary extends a narrow tract of land, called "the Hundred-feet Washes," included between the great barrier banks of the Hundred-feet and Old Bedford Rivers, 21 miles in length, and

varying from a few hundred yards to three quarters of a mile in width, having an area of about 5000 acres. This is used as a reservoir for the winter floods, and can be embanked only when the outfall is greatly improved. It is therefore uncultivated, but bears large crops of excellent hay; so that a great deal is used by the neighbouring farmers. This hay is coarse and long, but all kinds of stock will eat it; the eddish is stocked with cattle and young horses (which feed exceedingly well on it) until the winter months, when the floods may be expected. The fields (being parted by ditches) are then cleared, the gates removed, and when heavy downfalls come, and the swollen upland waters descend, these Washes are laid 6 or 7 feet under water, the roads across being traversed by ferry-boats.

Middle Level.—Northward of the Old Bedford River is the Middle Level, containing upwards of 150,000 acres, being the largest of the three levels. This Level is partitioned into the north, south, and east divisions, each being subdivided into numerous private districts, for the convenience of drainage. Under "the Middle Level River Act," passed in 1810, about 70,000*l.* were expended in scouring out and deepening the Old River Nene (which is the main artery of this Level), and nearly all the rivers and large drains, thus effecting a great improvement in the interior drainage, whilst the Eau Brink Cut wonderfully aided the work of benefit at the outfall.* The present mode of drainage of the Middle Level is principally by wind-engines, of which there are 150; and there are four steam-engines draining about 30,000 acres, besides three private engines, which drain about 1000 acres.

The Manea and Welney district engine is situated on the bank of the Old Bedford River, which (as before observed) empties into the Ouse at Salter's-lode Sluice. This engine is of 60 horse-power; the diameter of the water-wheel is 32 feet, width of the "ladles" 2 feet 9 inches, making 3½ revolutions in a minute. It drains 8685 acres, the cost of coals being 7*d.* per acre. The Sutton and Mepal engine is built a little higher up on the same bank, and throws its water into a small cut called "the Counter Drain," which empties itself into the Bedford River. It is 80-horse power; the diameter of the wheel being 32 feet, and the width of the ladles 4 feet, making 3½ revolutions per minute. It drains about 10,348 acres, costing 7½*d.* per acre for coals, &c. The March 1st District Engine is on the south bank of the Nene, about a mile eastward

* This cut gave an extra fall of 6 feet at St. Germain's (the upper end of the cut), and reduced the surface of the water in all the Middle and South Level rivers in proportion. This relieved the pressure on the banks, and prevented inundation, enabling the artificial works or mills to discharge the low land waters. Steam soon after began to be applied, and claying began to make great progress, so that the Middle and South Levels, from an oat-growing, became a wheat-growing country.

of March. It is 30 horse-power; the diameter of the wheel being 27 feet, the ladles 21 inches wide, making 4 revolutions in a minute. It drains about 3000 acres, the consumption of coals amounting to 11*d.* per acre. March 4th District, or "West Fen" engine, is on the north bank of the Nene, about a mile and a half westward of the town. It is 40 horse-power; the diameter of the wheel being 28 feet, the width of the ladles 2 feet, and it makes 4 revolutions per minute. It drains about 5000 acres, at a cost of 1*s.* 1*d.* per acre for coals. About 2000 acres of high-land water run into the two latter districts without paying any tax. The district drainage taxes are 4*s.* per acre in the two first districts; in the next 6*s.* per acre, and in the latter 5*s.* per acre; part of the taxes going annually in liquidation of money borrowed for the erection of the engines.*

It is believed that the artificial system of drainage is, in many districts, an unnecessary expense; and a great improvement in the main drains is now in progress. In the Session of 1844 an Act was obtained for "improving the Drainage and Navigation of the Middle Level of the Fens;" laying a tax of 1*s.* 6*d.* upon 130,000 acres, varying from 2*s.* 3*d.* to 3*d.* per acre. The object was, besides enlarging the old drains, and connecting them with some new, to make a new outfall to a more northern point, and therefore a lower level of the River Ouse. By this great cut the Tongs-drain (or Marshland Cut) will be useless, a dam being placed across this drain near the upper Tongs-sluice. This new channel from the upper end of the Eau Brink Cut to the Sixteen-feet River, about 11 miles long and 15 feet deep, is now completed, after much difficulty;—the weight of the banks having in many places forced up the bed of soft blue clay, the banks thus slipping into the drain. The other works cannot be executed until another Act is obtained, increasing the tax at least 1*s.* per acre. These works will carry away altogether the waters of Whittlesey Mere,—a lake spreading over more than a thousand acres of rich soil not more than 4 feet under water, and surrounded by extensive reed-beds. There is no doubt that steam power would ultimately have usurped entirely the offices of the windmills, had not these improvements been projected; it being

* The engines generally "dip" from 5 to 6 feet below the level of the surface when first erected; but a few years of good drainage consolidates the moor, and the surface is thus lowered very quickly. It is now generally understood to be the better way for a 40-horse engine to have three boilers of 30-horse power each, two to be at work, and one ready for cleansing or repairs if out of order. Experience has proved that two boilers of 30-horse power each will generate steam for a 40-horse engine with *less fuel* than one 40-horse boiler, as the furnace does not want so often disturbing to replenish the fire (thereby letting in the cold air), and the combustion is more complete. The cost of a steam-engine, including the building and fixing for purposes of drainage, is about 100*l.* for every horse power.

supposed that ten steam-engines, costing about 4000*l.* each, would drain the land much more effectually than the 150 windmills. By some it is hoped that the recent Act will give to three-fourths of the land a natural outfall; and that whenever the outfall below Lynn is improved, this benefit will extend to all. It is confidently expected that for a very large quantity of land neither windmills nor steam-engines will be required, and that for the remainder the cost for coals will certainly not exceed half the present amount.

The principal part of this Level consist of peat soil resting upon blue clay. The "Manea and Welney" district is principally moor, with generally good clay under it, and it is very productive land; some parts of it have a hard clay and gravel subsoil, but the surface is everywhere good. In "Sutton and Mepal" district the surface varies, but is generally black soil upon gault and gravel; the upper part of the district towards the high lands is mixed with brown clay, and the quality of the land good, and very productive. March 1st (or "Binnamoor") district has a considerable quantity of silt land; the remainder is peat upon blue clay, and very productive land. March 4th district, or "West Fen," is black land, with good clay from 2 to 5 feet below the surface, with some silty land made by creeks, which formerly conveyed the tides. The neighbourhood of Whittlesey, towards the north, is high land; a long strip of strong heavy clay extends into the fens from Bury to Ramsey; and a ridge of clay and gravel runs from March through Wimblington and Doddington, to Chatteris. On the high lands above Ramsey, the usual rotation is—1st, a dead fallow; 2nd, barley; 3rd, seeds, sometimes beans; and 4th, wheat. The chief part of the seeds is mown, and the aftermath grazed; but sometimes the clover stands for seed, which is ripe in September, about 8 bushels per acre being reckoned a fair average produce. There is a great deal of pasture land bordering upon the fen, which is most of it mown, so that an immense quantity of hay is there used. About March and Chatteris, both turnips and coleseed are grown on the high lands,—which are some of them a mild clay, and others a strong rich soil,—and after the green crop, generally oats; and wheat, beans or seeds, and wheat again. In the parish of March are 5000 acres of this land, on which a considerable extent of underdraining has been done. About Chatteris, Ramsey, &c., this has been widely practised with tiles with great success; but very little on the fen land, as the general drainage is not yet perfect.

Throughout most of the lowland, the clay is found at a depth of from 2 to 5 feet, though in some places it is ploughed up, and in others it is 8 or 9 feet beneath the surface; beds of gravel (near the highlands), or sometimes a stratum of turf being found

under 2 or 3 feet of clay. The land has almost all been "gaulted" once, most of it twice, and much of it three times. The common method of performing this was, to let the clay lie as long as possible to be pulverized by the frost; but by this means it was quickly "lost" in the peat soil, and the land soon required to be clayed again. The most general custom now is to plough in the clay very soon after being spread, and by thus being unexposed to the air, it remains in small lumps, keeping the soil in a more consolidated state for a long time. It has been previously remarked, that the black surface soil consists of the "moor" (which in most places forms the subsoil, 1 or 2 feet deep) in a further state of decomposition, from tillage and the influence of the atmosphere; and this substance (which is dug and dried into small sods called "turfs" or "cesses," for fuel) renders the land wet and cold; so that the aim of the fen farmer is to get rid of it in the best way he can. For this purpose it is torn up with a subsoil-plough, sometimes having 6 horses;—the harder portions, called "clunch," rising up in immense clods several stones in weight. This is crumbled by the frost; the land is soon after "clayed," and has then a most valuable and excellent alterative applied to it;—the moor, incorporating with the peat earth, becomes like it, and thus a very deep rich soil is formed. Throughout the whole of the Fens, the land which is not real peat-soil, having a portion of silt mixed with it, is liable to "honeycomb" during frost; that is, the frost separates about a 2-inch stratum of the surface soil into a netlike assemblage of small lumps, the soil beneath this perforated crust remaining exceedingly soft and light. This hard crust—pinching the blades of wheat whilst the roots are in the loose earth below—appears to *rise,* and the young plants are thus drawn out from their roots and laid on the top of the land. The pure black soil is not subject to this singular process, but freezes into a solid piece; on the lowest and wettest portions of silty peat it does immense mischief.

A very large quantity of land in this Level was a few years ago subject to be drowned by a heavy downfall, and some districts by a breach of the barrier banks from an overflow of high land water; but the improved drainage and practice of "claying" have improved the value of the land cent. per cent., and there are many instances of farms being purchased (within the last 70 or 80 years) at 5*l.* per acre, which are now worth from 30*l.* to 50*l.* per acre. Thirty years ago a farm of upwards of 500 acres was bought for 9*l.* per acre, and is now worth more than 35*l.* per acre. Wheat is the staple crop, and by high farming alternate crops are grown, varying the intermediate ones with beans, clover (both for seed and feed), rye-grass, &c., coleseed, and turnips. In the parish of March (containing 14,000 acres of fen land)

and in Chatteris Fen (about 10,000 acres) a common rotation is—1st, coleseed; 2nd, oats; 3rd, wheat; 4th, seeds; 5th, wheat; or when the seeds remain for two years the lea is deep ploughed in winter for fallow. Or sometimes—1st, coleseed; 2nd, wheat; 3rd, seeds; 4th, wheat; and often 5th, beans; and 6th, wheat again. A very great quantity of linseed oilcake is used in the farm-yards, and bone-dust for the green crop invariably. Rape-cake and guano are used to a considerable extent, and it is also become a common custom to sow white mustard with guano, to be ploughed-in for manure. About Ramsey and Whittlesey the mode of management is much the same, the usual course of cropping pursued on the estates of Mr. Fellowes being—1st, coleseed; 2nd, oats; 3rd, wheat; 4th, seeds; 5th, wheat. Some farmers occasionally take oats after coleseed (which has had 10 or 12 bushels of bones per acre), then wheat, next "clay" for oats, and then manure for wheat again. Very few turnips are grown, but some excellent crops of carrots and field-beet are produced. In many places some extraordinary yields of wheat have been obtained;—some farms averaging 6 qrs. per acre, and some single fields producing 7 or 8 qrs. per acre. The most general breed of sheep is the long-woolled; and they are fed upon cole-seed for three-fourths of the year,—the principal part of the seeds being usually mown.

Near Whittlesey Mere is Holm Fen, of about 5000 acres, which not many years ago was an immense reed shoal—the resort of almost all kinds of waterfowl; but it is now inclosed, has been wonderfully improved by claying, and bears abundant crops of corn. Adjoining to it is Middlemoor, containing about 2500 acres, spoken of by Arthur Young, in A.D. 1800, as "a watery desert, growing sedge and rushes, and inhabited by frogs and bitterns;" it is now fertile, well cultivated, and profitable land. The clay in this locality is found at a great depth,—perhaps 7 or 9 feet from the surface—so that, although there are but few pieces of land in this part of the Fens which have not been clayed once, and many twice, yet it is not practised so much as is need ful; the operation (at this great depth) costing about 4*l.* per acre. An encroachment has been made upon Whittlesey Mere (which will shortly be completely drained); and a steam-engine has been erected, which drains the new inclosure from the Mere—of about 500 acres—throwing the water into the Mere. Ramsey Mere, containing more than 560 acres, and Ugg Mere, a smaller sheet of water, were drained and inclosed a few years ago; each having a windmill throwing its water into the Nene. Ramsey Mere, which once grew enormous quantities of long reed (used for thatching in the neighbouring counties), now comprises three farms of beautiful land, on a higher level than the surrounding

fen. And this Mere has now farm-buildings built upon its bed, a good gravel road running through the middle of it, and produces fine crops of wheat and oats.

The drainage of the whole of this level, with the exception of the steam-drainage before mentioned, is by windmills, the country being divided into "small districts" and "private drainages," too numerous to mention. These mills are generally attended to by men who live in them; the millman, in the summer months, being paid for the time during which his mill is of necessity going, having his tenement thus rent-free; but in the winter months he has orders to work his mill whenever there is a wind, and is paid a continual weekly sum—generally about 2*s.* per day. In many instances these "districts" are tolerably well drained, except in wet seasons, when there happens to be a layer of wind.

North Level and Portsand.—The North Level, and Portsand (which is united with it), containing about 48,000 acres, comprises that portion of the Great Bedford Level which is included between the north bank of Moreton's Leam and the south side of the Welland. Of these 48,000 acres, only 39,622 acres are taxable lands; the district called Newborough (formerly "Great Borough Fen Common," drained and inclosed by an Act, passed 52 George III.), containing 5276 acres; Flag Fen, Sutton St. Edmund's Great and Little Commons, about 2500 acres, being exempt from the general North Level Taxes. The taxable lands are divided into five districts;—the water from the whole level being conveyed by the Old and New South Eau to a place called Clow's Cross, and from thence by the North Level Drain to the river Nene, below Wisbech, at Gunthorpe Sluice. Previous to the improvement in the Nene outfall, this Level was in a most deplorable state. In A.D. 1770, a great breach, which occurred in one of the river banks, 130 yards long, and 36 feet deep, inundated the level—laying the whole of it 7 or 8 feet deep under water. In 1795 all the other banks gave way, only the district of Portsand and Thorney Lordship escaping the devastation of the flood. The necessity for improving the outfall became more apparent as the number of floods increased. During the whole of the winter preceding the terrible floods of 1799, both of which happened in February, the Hundred-feet and Whittlesey Washes (in consequence of the bad state of the outfalls) were 2 or 3 feet deep in water, and therefore afforded so much less a receptacle for the waters poured in from the highland counties. The water of those Washes was frozen to the ground, on which came fresh floods; so that at last the *ice* was, in some places, *twelve or thirteen feet thick;* and it was the accumulating of the ice of these floods at various points that did the principal mischief. This could not

have occurred, had the present Eau Brink Cut and improved Nene Outfall been in existence. In 1809, Mr. Rennie made a report upon the drainage of this Level, projecting extensive plans of improvement, both as regarded the internal drainage of the North Level, South Holland, the Hundred of Wisbech, the Whittlesey Washes, and the outfall to sea; but this plan was not persevered in, the Level remaining in its lost condition until the passing of the Nene Act in 1827. This included the drainage of the Fens as follows:—

	Acres.
The North Level and Portsand	48,000
South Holland, including part of Sutton St. Mary's, and Tidd St. Mary's	34,000
Sutton St. Edmund's	5,700
Wisbech Hundred, including the parishes of Tidd St. Giles, Newton, Leverington, and Parson Drove	17,700
Waldersea and Begdale	8,000
Lands in Moreton's Leam Wash . . .	3,500
	116,900

To this undertaking—

The Bedford Level was to contribute . .	£48,000
The Corporation of Wisbech	30,000
Wisbech Hundred, and Tidd-fen . . .	15,000
South Holland Drainage	7,000
Lands in Sutton St. Edmund's . . .	1,700
Hamlet of Sutton St. James's	550
	£102,250

These works, as before observed, were completed in the year 1831; a new cut, called the North Level Drain, about 6 miles in length, being made from Clow's Cross to the Nene;—the water thus passing through a wide, deep, and more direct channel to the improved outfall, instead of winding round by the narrow and imperfect Shire Drain. This was an incalculable benefit; formerly the land would not remunerate the farmer for high cultivation and quick succession of crops, but it has greatly improved since. There were about thirty windmills, and one steam-engine (in Borough Fen, near Thorney) in this level; but in consequence of the above, and other vast improvements, "there are now neither steam-engines nor windmills remaining,—the whole drainage being accomplished by the natural descent of the waters to sea," at an annual expense of 4*s.* or 5*s.* per acre. The higher parts of the level are exceedingly well drained, but the lower parts only imperfectly, partly owing to the water being held up at Sutton Bridge.

The origin of "paring and burning" in the Bedford Level was in this district, about the middle of the 17th century. The paring-plough, used in the neighbourhood of Thorney and Whittlesey, was called "the French-plough," and was probably introduced by a colony of French Protestant refugees, who settled at Thorney about the year 1650. These French families had been driven into Holland, and thence came to Thorney; brought most likely by the report of the Dutch engineers, who at that time were employed in the drainage of the Fens; and there is little doubt but that these emigrants introduced the practice of paring and burning in this part of the kingdom, as we know, by the work of De Serres, that it was common in France fifty years before that period. This practice was universal previously to the improved drainage; the usual system being to pare and burn for coleseed, take two crops—one of oats, the other of wheat; and then lay down grass-seeds for three, or perhaps more years. The soil, with the exception of some high lands of clay and gravel round Thorney, and alluvial soil in Portsand, &c., is *peat* or vegetable mould, averaging not more than 12 to 18 inches in depth. Claying is now *universal*, and much the same mode of management and cropping is adopted here as in the other districts; the general system now prevalent being a 5 or 6 course shift, viz.—1st, fallow for coleseed, or *turnips;* 2nd, oats; 3rd, wheat; 4th, seeds; and 5th, wheat; and next time, fallow for—1st, coleseed; 2nd, oats; 3rd, seeds; 4th, wheat; 5th, beans; and 6th, wheat. The "third district," or Thorney Lordship,—containing 17,588 acres, the property of the Duke of Bedford,—is noted for its good management and neat farm-steads; upon this estate, and other parts of the Level, very much upon the *fen* as well as highlands, a wide extent of underdraining has been done with a very good effect—improving the condition of the soil, and saving much annual expense in surface-draining. Much of the old pasture land, which was good and valuable under the old system of drainage, has been converted into arable, having been rendered *too dry* for pasturage, and much more valuable and *most productive* for corn. The North Level may be regarded as possessing altogether a more complete and improved drainage and agriculture than any other district of the Fens.

Norfolk Fens.

Downham Fen.—South of Marshland is a triangular portion of fen land lying in Norfolk, divided into Bardolph and Downham Fens. The latter, which contains about 1600 acres, is drained under the authority of an Act passed in 1802; two windmills (or *one* "double-lift,"—that is, one mill working *behind* another, to raise the water *successively* to the required

height) being erected upon the banks of Well Creek, discharging the water through Salter's-lode Sluice into the Ouse. The "head" of water to be thrown against is sometimes 12 feet, so that steam-drainage would be very expensive in so small a fen, and part of it bad land. In 1840, an attempt was made to introduce steam-drainage; an engine was erected, and made to work neither a water-wheel nor a pump, but some of "Hall's Patent Hydraulic Belts." After a trial, however, it was found that the scheme would not answer; and Downham Fen still continues under wind-drainage,—although "the farmer, in the midst of his confidence and hopes, with his crops ready for the sickle, has sometimes experienced sudden and complete ruin from an unexpected fall of heavy rains deluging his lands; while his mills —his only hope—stood with their sails unmoved by a breath of wind, and the fruits of the labour and industry of the past year perished on the ground." The soil is peat, about 5 feet in depth;—there are only one or two fields which have not been clayed. The land is higher near the river, and a few tile underdrains have been laid there; but the greater part is too low and wet to admit of such an improvement. The chief crops are wheat and oats, but this fen has been badly managed, having had no green crops on it for a long time, excepting a few patches of turnips now and then on the higher lands, and a few acres of coleseed. Linseed oil-cake is used to improve the yard manure, a few bones and a great many "mussels" are put in the land— which lies contiguous to the river, these shell-fish being brought up in barges. It is singular that nut-trees have been discovered beneath the soil, with sound good nuts upon them; the roots which are found are nearly all of the sallow. Fourteen or fifteen years ago the Ouse bank broke, by reason of a tunnel blowing up, and nearly the whole fen was inundated. The harvest-men were obliged to stand on a platform to reap the corn, being carried to and from the high land in boats; and the farmers were some of them compelled to row boats into their orchards in order to pluck the fruit from the trees.

Bardolph Fen.—North of this district is Bardolph Fen—comprising 5235 acres. The drainage is by two principal mills, standing at the extremity of the fen next the Ouse, into which the waters are thrown, between Downham and Stow Bridge. The soil is generally a deep moor, about 5 feet; and both in this and Downham Fen frequently occur white beds, at the surface apparently like chalk, but consisting of decaying shells. The same remarks which have been made respecting the management of Downham Fen will also apply to this district; most of it has been clayed once, but the practice has been to keep cropping it one year after another, with scarcely any fallow whatever, the course being coleseed, oats,

wheat, beans, wheat, beans, wheat, &c., but little or no seeds, and not 100 sheep grazed on the whole fen. Artificial manures are of course employed to enable the land to bear this; but in consequence of the inefficient drainage, a great portion of the manure applied, being washed downwards into the wet and spongy moor, soaks through it into the ditches, and a remedy by underdraining is scarcely practicable because of this wetness. A good steam-drainage is much needed in both these fens, to dry and condense the stratum of moor; and some good dressings of clay, combined with deep subsoil-ploughing to break up the moor, are required, thoroughly to improve them.

Magdalen Fen.—North-eastward of Bardolph Fen is a part of Marshland called "Magdalen Fen," containing about 4000 acres, which until the year 1833 was under the ruinous system of windmill drainage; and the following instance gives a striking contrast between the two methods of wind and steam. A farm of nearly 700 acres, paying 291*l.* per annum drainage-tax, lost the occupier 3000*l.* during the last five years of that wretched drainage; after a great deal of trouble and expense an engine of 40-horse power has been erected, and the same farm is now *well* drained at a cost of only 254*l.* per annum. This fen is on a lower level than Bardolph Fen, having a "head" of 8 or 10 feet, and sometimes 12 or 13 feet; and in wet seasons the engine is hard-pressed to lift out the water, a large basin (for the engine to throw into) being required to hold the water, which can pass through the sluice into the Ouse only at low tide. The soil is black peat, resting upon beds of clay and silt. Before the improved drainage, the crust of moor was about 4 feet in thickness, but it has now become so reduced and compressed that it is not more than 2 feet deep in any part, and in many places the clay may be ploughed up.

The old system was to pare and burn for oats, next take a crop of rye, and then let the land *lay itself* down with couch, grass, reeds, &c., for three or four years. In consequence of this, too much of the peat has been burnt away, and the farmers find that their land will, ere long, be mixed with too much clay and silt. A great portion of this fen (all arable) has been clayed twice: the first plan being to clay the coleseed stubbles, and to sow oats upon the fresh clay just as it was thrown out from the "dikes," without ploughing; but it is now done before and after *any* crops, as early as possible in the winter to have a good frost upon it, and ploughed-in in spring. Immense quantities of trees and roots are being constantly dug up in this fen, good fir-poles are found, and the roots (which are all fir and burn fiercely, being still full of turpentine) are so plentiful that, though every year all that the plough touches are taken up, still numbers are

every year found, and some of the farm-yards are walled round with piles of them.

There is no general mode of management adopted here, but the following rotation is highly approved of, viz.,—1st, coleseed; 2nd, oats; 3rd, wheat; 4th, seeds; of which *half* are mown and the aftermath grazed (generally by equal numbers of half-breds and long-wools), being ploughed up again for 5th wheat. The other half remains down and is grazed for two years, the crops being thus,—5th, seeds; 6th, beans; 7th, wheat.

The wireworm is so destructive, especially on the silty or sandy parts, that a wheat crop is often entirely lost; but where the land is tolerably free from its ravages, 52 bushels of wheat per acre are frequently grown. Bone-dust is invariably sown with the fallow crop, about 10 bushels per acre, with ashes made by burning side-parings from the ditches, &c., and guano answers well. The drilling of guano with the coleseed had been objected to, as in several cases it had killed the seed; but some farmers have obviated this by sowing it with a double-coultered drill, and fixing a thorn on each of the first or guano coulters to brush it in before the seed is deposited, thus preventing the seed from coming in contact with the manure. About 2 cwt. per acre have produced some excellent crops. Oilcake is used in the straw-yards, the cattle generally having 4 lbs. a-day each during the winter, and are sold in spring ready to be "made up" on the summer pastures. No under-draining has yet been attempted in this fen.

Marshland Fen.—Westward of Magdalen Fen is another district called Marshland Fen, extending towards Outwell, and divided from Bardolph Fen on the south by the Old Podike. This tract of land was inclosed and drained under an Act of the 3rd Geo. III., and allotted to eleven different parishes in Marshland, which had previously rights of soil and common thereon. Prior to the drainage this fen was a complete reed shoal, the resort of fowlers and sportsmen, and was used as a reservoir for other fen waters. In the Drainage and Inclosure Act were included Marshland Smeath (a similar tract bounding it on the north-west, at that time one waste of water), Wellmoor in Outwell, and Broad and Short Fens in Wiggenhall. It contains a total of 7263 acres. The drainage was effected 50 years ago by 4 powerful windmills, quite sufficient to have drained it effectually if they could have been worked at all times, but from the uncertainty of the power, the crops were often much injured. This district has now shared the benefit of the improved outfall, in being *better* drained with only 2 mills than formerly by the 4. These 2 mills, standing at the North extremity of Marshland Fen, throw their waters into the "Smeath-and-Fen" drain, and thence by the new Marshland

drain and sluice, into the Ouse, above the Eau Brink Cut. It is a great pity that these last mentioned districts should still rely on artificial means of drainage, since, had there not been so much opposition to the Middle Level Commissioners, when trying for their late Act of Parliament, the new works would have been carried out to sea (the outfall below Lynn being in a very bad state, in consequence of its shifting and circuitous channel, and numerous sand-banks), and these fens at any rate, if not the whole of the Middle and South Levels, would have had a perfect natural drainage.

The soil of Marshland Fen is a black peat, formerly so soft that wooden shoes, that is flat boards, were nailed on the horses' feet over the iron ones, to prevent them from sinking in; and even now it is difficult for them to travel on the wet and spongy roads. This soil was once very deep, but it is now so condensed that the depth varies from only 6 or 8, to 18 or 20 inches. A subsoil of good clay pervades most of the district, and the usual custom now is to plough very deep, by which this is brought up and mingled with the soil. The course of cropping is much the same as on other good fen land, turnips being grown as well as coleseed, the fallow crop always having about 10 or 12 bushels of bones per acre. No underdraining has been done, as the water in the ditches is seldom more than 18 or 20 inches below the level of the surface; but though badly drained, this fen is much improved in value, having been worth about 10*l.* per acre to the fowlers and fishermen, and selling now for 50*l.* per acre.

The present state of the Great Level will admit of many improvements, all on the most extended scale, in order to secure as perfect a drainage as possible. The Ouze, Nene, Welland, &c, and all the minor rivers, must be deepened to the full extent required; the "Victoria" project completed to the full extent of Sir John Rennie's Report, and the fen waters must then be carried to the *lowest* point towards the sea before they are united with the upland waters. This great scheme will doubtless be accomplished before many generations have passed away; and the Great Level, thus rendered the most fruitful district in the kingdom, and a new country wrought from the waves of the ocean, will be the marvel of a future age.

The Marsh District.

Having now run briefly over the various divisions of the Bedford Level, with the contiguous Norfolk Fens, it has been deemed not inappropriate to bring under consideration, before proceeding upwards to the Fens of Lincolnshire, that tract of higher land

called "the marsh district," which intervenes between the Fens, properly so called, and the ocean. Indeed, so interesting a country, originally reclaimed from the dominion of the deep, and forming a large portion of what is, in its most extended sense, the Great Level of the Fens, cannot properly be omitted.

The *whole extent* of flat country between the hills and the sea may be regarded as an alluvial deposit, the principal part being now a blue clay. The Black Fen districts consist of all those localities where vegetation once flourished, but has since perished and decayed; thus forming a crust of vegetable mould over the former soil. Nearer to the sea, and principally in Lincolnshire, is a breadth of the same deposit which has remained *unclad* by those immense primeval forests, and is on a higher level; and then, bordering upon the ocean, are still later deposits of loam and silt, which constitute the Marsh district. The two latter compose the level tract, which has been previously described as extending from Lynn, through Wisbech, Holbeach, Boston, &c., to Wainfleet, and forming a margin, of considerable breadth, for many miles up the various rivers which empty themselves into the Wash. It may be estimated to embrace not less than 130,000 acres; the accumulation of alluvial matter being of varied thickness and texture, and deriving its character from the nature and quality of the particles of highland soil brought down by the rivers.

Marshland.—The first district then to be noticed is that of "Marshland," in Norfolk, the adjoining fens of which have just been adverted to. It lies principally between Lynn and Wisbech, and contains about 30,000 acres, comprising 17 parishes. The soil of the whole is the subsidence of a muddy water, with what the waves, powerful in their agitation, had washed from the bottom of the adjoining gulf which forms the embouchure of two considerable rivers. It is a mixture of sea-sand and mud, which is of so argillaceous a quality, probably owing to the stiff upland country through which the Ouse flows, that the surface soil which covers the sand is strong and tenacious enough to be regarded as clay. The whole country having been a present from the ocean, there still remain ranges of banks at a distance from each other, showing the progressive advances which industry has effected, eager to seize the spoils which so dreaded an enemy has relinquished. One of these banks is called the "Roman;" its distance from the shore is not so great as it would have been, had the sea in all ages been as liberal as it is in this. The whole country was liable, upon a breach of the outermost, or "sea-dike" bank, to be inundated; and history furnishes numerous instances of such a catastrophe, the most terrible being one which occurred in A.D. 1613. On the 1st of November, "late in the night,

the sea broke in, through the violence of a north-east wind, meeting with a spring-tide, and overflowed all Marshland, with the town of Wisbech both on the north and south sides, and almost all the whole hundred round about;" the loss of property amounting to 37,000*l*. So wide was the devastation of the waves, that, besides thousands of cattle and sheep swept away by the rage of the sea, vast quantities of grass, hay, and corn lost, and hundreds of dwelling-houses "utterly destroyed," numbers of people were drowned in their beds. At Terrington, "a frontier town," where the breach was made, "in this distress the people fled to the church for refuge, some to haystacks, some to the baulks in the houses till they were near famished, poor women leaving their children swimming in their beds, till good people adventuring their lives, went up to the breast in the waters to fetch them out at the windows: and had not the mayor and aldermen of King's Lynn compassionately sent beer and victual thither by boat, many had perished; which boats came the *direct* way *over the soil* from Lynn to Terrington." There is now little danger of such an irruption, as the barriers have been extended further seaward, and stronger banks constructed round the more recent inclosures.

Previously to the formation of the Eau Brink Cut, it was exceedingly badly drained. A great number of acres in each parish used frequently to be flooded, so much so indeed, that it was a hazardous speculation to sow the low lands with wheat, although there was generally some artificial means of drainage, by small windmills, &c. From the beneficial effects of the Cut, the same lands are now as well drained as can be desired; and of course are very materially improved in fertility. The great leading drain into which most of the waters run, is the Marshland Great Sewer, or "Chancellor's Lode," lying south of the Old Marshland, which conveys the waters into the New Marshland drain and sluice, to the Ouse. The other chief leading drain is that which conveys the waters to the West Lynn Gool, and by that into the Lynn channel. The soil on the old lands varies very much: some being a rich deep loam, some a very strong tenacious clay, and some again a nice mixed soil. That part of this district lying immediately between Lynn and Long Sutton is chiefly under arable culture, and is a stiff clayey loam, producing large crops of wheat and beans. The more common course of management in this marsh is,—1st, a bare fallow, sometimes coleseed or turnips; 2nd, wheat; 3rd, beans, or clover; followed by 4th, wheat. If the fallow be a turnip crop, the land is sown to 2nd, oats, and then 3rd, wheat; 4th, beans, and 5th, wheat. In each parish there is a little fine old pasture-land, although a great deal has of late years been converted into arable. Further back from the sea there are large tracts of good grazing ground, the soil

being a rich dark loam. These lands sustain very heavy stocking—from 8 to 12 half-bred Down-and-Leicester sheep per acre, with 1 steer to 4 acres. The arable lands in this part of Marshland are very productive, growing large quantities of potatoes, besides several crops of corn and pulse in succession.

Marshland Smeath, containing 1572 acres, is an exceedingly rich tract, being a strong heavy loam, with a subsoil of clay and silt mixed, and in some few places, moor, being "skirty" along the boundary drain which parts it from Marshland Fen. Dugdale mentions "a famous plain, called the Smeath, which, being common to all the towns in Marshland, maintaineth at least thirty thousand sheep; and yet is not of a larger extent, in the widest part of it, than two English miles." This was enclosed under the Marshland Fen Drainage Act, and is now most part of it arable, with only a few pieces of pasture. It is so fertile that, 1st, oats; 2nd, seeds; 3rd, wheat; 4th, beans; 5th, wheat, &c., are continually grown; the land being thus cropped (with a dead fallow at long intervals, and a great deal has never been fallowed at all) *without any manuring whatever.* Very little artificial manure is used in the whole of Marshland. Under-draining has been introduced during the last six or seven years, and will most likely become general in a short time, though not a tenth of the land has been done at present. Wood-draining has been done with good effect, and wedge, or sod-draining has been found to stand well for five or six years; but both these methods have now given place to the best and safest one of tile-draining. The drains are usually about 18 yards apart, and $3\frac{1}{2}$ feet in depth; the tiles or "pipes" are tubular, fitting together in rings of 5-inch breadth, called "collars," or sometimes "rests" are used, that is, half-collars, which hold the ends of the pipes *flush* with each other. The general rate of payment to labourers for this work is 5*s.* 6*d.* per "score," that is, twenty $16\frac{1}{2}$ feet rods, making about $3\frac{1}{4}$*d.* per rod; and the men will earn thus about 2*s.* 6*d.* per day.

A large extent of land has been added of late years to this district. Among other acquirements, the tract of 786 acres, formerly part of the Old Lynn channel, lying between the Old Marsh lands and the Eau Brink Cut, may be considered as part of Marshland. This, which is now becoming good land, was once the great impediment to the passage of the Fen waters. Marshland Fen, as before stated, formerly served as a receptacle for the flood-waters, and seldom any flood-water passed to sea until about Christmas, or when the fen was full; and this being also the case with the Hundred-feet Washes, the whole combined was one great cause of the sand-banks forming across the channel of the old river, in consequence of having so little ebb water for eight or

nine months in the year; indeed, it was almost invariably the case, previous to the Eau Brink Cut, that the deep channel for the ebb water would shift alternately, summer and winter, from one bank of the old broad river to the opposite one. Before the new channel for the river Nene was made, there was a wide and shallow gulf between Marshland and the Lincolnshire coast, through the midst of which the old river pursued its winding and variable course, greatly obstructed by sand and mud. The new channel was cut along the Lincolnshire side, and an embankment made, cutting off a great portion of the gulf from the sea, which, with the bridge across the new river, forms a road connecting Marshland with Lincolnshire. About 1300 acres of the salt-marshes and bare sands called the Outmarsh of Walpole, were thus reclaimed, and are now inclosed and cultivated, having houses and farm buildings erected in different places, and producing crops of corn. The outmarsh belonging to each parish is stocked with sheep, although liable to be daily overflowed by the tides; the first plant that appears is the marsh samphire, next the "triticum repens," or "sea-wheat," and by degrees grasses rise; and immediately after embanking, broken as it is by holes and small creeks of water, it is stocked with cattle or put under the plough. Since the 1300 acres were inclosed, in consequence of a further accumulation of sediment outside the embankment, another great work is in progress. Another breadth of the same gulf is being reclaimed by means of a bank from the Marshland coast to the new channel of the Nene. This bank, which will be 3½ miles long, projects at present only part of the distance; a smaller one, called the Cradge Bank, has been extended across, inclosing about 2500 acres, which is valuable land, having very little light soil or creeks. When the main bank is shut up (which will be in a few years, having been commenced in August, 1842), about 1000 acres more will be gained. There are 2000 acres more, lying outside this embankment, which will be taken in when considered fit for cultivation. Experience has shown that the ground ought to be covered by nature with samphire or other plants, or with grass, before an attempt is made to embank it; there is particular danger in being too greedy. "If the sea has not raised the salt marsh to its *fruitful level,* all expectation of benefit is vain, the soil being immature, and not ripened for inclosure; and if, again, with a view of grasping a great extent of salt-marsh, the bank or sea wall be pushed further outwards than where there is a firm and secure foundation for it to stand upon, the bank will blow up, and in both cases great losses and disappointments will ensue."

The thickness of warp deposited by the sea varies much according to the height of the land, some lowland having been

known to make up 2 feet in a year, and in some cases only as many inches. When the sea is shut out from the new made land, it continues depositing soil in the deeper water beyond; and in this manner it is proposed to reclaim nearly the whole of the great estuary called "the Wash." The district already inclosed and in progress, comprising altogether about 5000 acres, is called "Wing Land," in honour of Tycho Wing, Esq., of Thorney, near Peterborough, to whose energy and perseverance the improvement is mainly attributable.

An Act has been lately procured for the execution of a gigantic and magnificent undertaking, called the "Victoria Level." The plan is to conduct the rivers Ouse and Nene, Welland and Witham, to a new general outfall in the centre of the present estuary, and by means of embankments convert the whole bay on each side of the proposed channel into valuable land. It is estimated that there will be 150,000 acres in the new country, extending between Wainfleet in Lincolnshire, and Hunstanton in Norfolk, of which 73,000 acres are already land at the receding of the tide, and 4000 acres are valued at 40*l.* per acre.

But, to return from this digression: south of Marshland country are some very rich pasture lands. There is also some good arable land, and good grazing ground on the high lands which run from Elm in the direction of March. South-west of Elm is the district of Waldersey, principally a moory soil, containing 8000 acres. It was drained a few years ago entirely by windmills, but they performed their work very badly, as it was customary during wet seasons for boats to be rowed over the land, which was the habitation of large numbers of wild fowl. In 1832 a steam-engine was erected at a cost of 3000*l.* It is of 60 horse-power; the expense for coal is 150*l.* per annum, and it drains about 6500 acres of very fine land at a drainage-tax of 4*s.* 6*d.* per acre. A portion of debt is paid every year out of this sum; when it is liquidated, the tax can be reduced to 1*s.* 6*d.* per acre. The waters are raised by one pump, 6 *feet in diameter,* which lifts 63 tons of water per minute, from 10 to 20 feet high, according to the height of the tide. A few mills still remain, which are used in addition, upon some private farms, when there is a great fall of rain. It is thought that if Wisbech and Sutton bridges were either removed or enlarged, there would be a natural drainage, without the great burthen upon the land which now arises from the yearly expense of both steam and wind. The land has not *all* been clayed, but will be in a few years. Underdraining has been tried only as an experiment, and answers so well that it will probably come into extensive operation before many years have elapsed. Bone-dust is always used, and with very good effect, for the fallow crop, coleseed, after which oats

are sown; then the stubble is manured with fold-yard manure and sown to wheat, next clover or beans, and then wheat again.

The lands in Wisbech Hundred are about 17,700 acres, and within this district some beautiful spots of high land have been brought under culture, producing immense crops of potatoes and grain. In the parish of Leverington, near Wisbech, is a peppermint distillery, one of the largest in the kingdom, and the culture of the plant for distillation has been of great benefit to the poor in the neighbourhoood, producing employment for a great number of boys (who are engaged in its setting, weeding, &c.); this, with the large breadth of potatoes annually grown on the same land, has caused a vast increase of labour of a profitable kind. For the growth of peppermint the land is thoroughly worked, cleaned, and manured, so as to render it as rich as possible. In planting, from 200 to 300 men, women, and (chiefly) boys are variously employed—in taking up the plants (which are generally the offshoots of old fields or beds), leading them to the field, setting, &c. Round holes are made with long wooden dibbers, in which the young plants are set, in rows about 18 inches apart, the after-culture consisting chiefly in hoeing and hand-weeding. The crop is fit for distillation in the early part of harvest, when the work of gathering proceeds with the utmost expedition. It is cut green, in its full growth, and taken to the distillery in such quantities as to prevent fermentation.

Lincolnshire Fens.

South Holland.—North-westward of Wisbech Hundred, and north of the North Level and Portsand, stretches that part of Lincolnshire called South Holland, bounded on the west by the Welland, and on the north and east by the sea, containing about 80,000 acres. The whole country has long been an object of embankment. Ravenbank, the origin of which is quite unknown, appears to have been the third which had been formed for securing a small part of this tract from the sea, leading from Cowbitt across to Tidd St. Mary's. About 6 miles nearer to the sea is another bank, called the Old Sea-dike, or Roman Bank. A fifth bank, called the New Seadike Bank, 2 miles nearer than the Roman, remains, but it is utterly unknown when or by whom it was made. A curious circumstance is, that the surface of the country is 6 feet higher on the sea side of the old Roman bank than on the land side, being the depth of warp deposited by the sea since it was made. In 1792 another embankment was made, taking in certain salt-marshes and low lands extending along the shore, having an area of about 5339 acres. The lands lying in Peakhill and several neighbouring parishes were formerly drained by the Welland, and

also by Lutton Leam, the waters having to pass through the higher lands, viz., to the north and north-east, and thus a large and very valuable tract of country was drowned three-fourths of every year. In 1793 the proprietors procured an Act for the drainage of South Holland, and in 1794 and 1795 a new drain was made, extending from Peter's-point (near Sutton Bridge), where a sluice was erected to keep out the Nene tides up to Peakhill, near Cowbitt Bank, 14 miles in length, together with two other drains, viz., the "Highlands" drain, about 5 miles long, and the "Lowlands," about 4 miles. The district thus drained comprised about 32,000 acres, including the lands drained by the Lords' drain, which empties its waters into the Welland at Wragg Marsh, near Spalding. In consequence of the engineer taking the outfall to the wrong place, the proprietors, who paid from 20*s.* to 30*s.* and 40*s.* per acre, received very little benefit, and the drainage remained in a very imperfect state, the Nene Channel being blocked up by sand-banks until the improvement of the Nene Outfall in 1831. Prior to this work, the waters on the cill of the South Holland Sluice have been known to rise, during the summer season, with the sand-bed 5 feet on the apron, and in winter the water was seldom lower than 2 feet 6 inches. Now it has a fall off the cill, at low water, of 2 feet 9 inches, although the middle arch was lowered 12 or 14 inches. This district has a natural drainage, but in wet seasons is not so well drained as it ought to be: a new sluice being required, to be laid about 4 feet lower than the present one. The parish of Sutton St. Edmund's, including a small part of the lands in Tidd St. Mary, and Sutton St. James, containing about 5700 acres, north of the Shire Drain, discharges its waters by that drain. The lands near the sea drain by Lutton Leam, Moulton Creek, &c., besides which there are numerous tunnels through the sea-bank, for the drainage of private estates.

The land near the Nene consists of a good thick loam upon a porous silty subsoil; as it widens out from the river it becomes more adhesive, being a fine deep alluvial loam, of a dark brown colour, an admixture of clay, silt, and moor. In many places are found evidences of too early an enclosure from the ocean, the soil being silty, with too thin a surface of loam. This tract comprises some of the finest arable land in the kingdom, having been brought into cultivation for corn, potatoes, mustard, and woad, with astonishing crops. The land most suitable for woad is the richest that can be procured, and will bear from 3 to 5 crops in succession, after which it is devoted to the growth of corn. There are some large woad establishments in this part of the country, which are moved about to different localities, as land is obtained for the purpose. The buildings are such as may be

readily constructed, or removed to another site and rebuilt; a commodious round hovel is erected for the mill, and the drying-sheds are generally built in a quadrangular shape, consisting of a light framework of fir-deals supported by stays or props, and a roof of light weather boarding. Tiers of "fleaks," a kind of wattled hurdles, are laid across the woodwork, upon which the woad is dried. The usual time for sowing the seed is about the beginning of April; the land is prepared by good ploughing, &c., until a fine mould is obtained, the seed is then drilled, lightly harrowed in, and the field all raked over by hand, every grass sod or other refuse being carefully taken off. When about 4 inches high it is cleaned by hoeing and hand-weeding, and when 8 inches high it is ready for plucking. This is done by a number of men, women, boys, and girls, upon their knees, each having a 4-bushel basket to receive the woad as it is pulled, the payment being according to the number of these baskets filled. Large carts are generally in attendance to take the woad to the mill, where it is crushed into a pulp by the rolling over it of large wooden wheels, having teeth about 4 inches apart, shod with iron. It is then laid in a heap for some time to "heat" a little, and afterwards made into balls about the size of a 34 lb. shot, placed in the sheds to dry, and finally, packed in large hogsheads for market.

Lying between this tract and the fen is the usual breadth of highland fen, consisting chiefly of clay and clayey loam; and in the township of Long Sutton, extending to St. James's and St. Edmund's, much valuable land is found, the arable in excellent cultivation, producing mustard, coleseed, corn, and pulse, and the grazing ground of first rate quality. The parishes of Whaplode, Moulton, and Weston have the same kind of alluvial loam already alluded to, part of the marsh adjoining the Welland being a light silty loam, though there are some exceedingly good grazing grounds. The pastures in all the marshes, from their proximity to the silt, cause looseness and scouring in cattle, whilst the southern parts of all these parishes, being on clay, are healthy and very nutritive. This bad property of the herbage on the marsh lands may perhaps be owing to the *soak*, which pervades almost all the districts of the Lincolnshire fens having a *silt* subsoil. This subterranean water is found at various depths, usually but a very few feet below the surface; it rises and sinks according to the season, and is supposed, from its saline quality, to be the sea-water filtered through a stratum of silt.

At the southern extremity of Moulton parish is the district of Portsand, containing some high land, with pastures of first rate quality. This is now united with the North Level drainage. The mouth of the river Welland (which is the northern boun-

dary of South Holland) divides Moulton from Fossdike, which contains much beautiful land. Nearly all of it is marsh and highland, some of the lands westward of the village are very strong, approaching gault in stiffness.

From this parish towards Boston are Sutterton and Algarkirk, both possessing prime grazing and arable land. A Yorkshire Company have taken a great breadth of the best lands in these parishes, at a high rent, on a 90 years' lease, for the cultivation of woad, chiccory, &c. They have an extensive establishment at Algarkirk for the manufacture of chiccory, as a substitute for coffee. The land is ploughed very deep in the spring and well worked, every weed carefully picked off, and when reduced to a perfect pulverization, about the third week in April the seed is drilled in rows 9 inches apart, and harrowed lightly in, the cloddy parts being raked off into the furrows. The plants are hoed and weeded repeatedly, and at Michaelmas the crop is ready for taking up, which is done as follows: the leaves, which are exceedingly good food for all kinds of stock, are gathered off, and either thus consumed or applied to manuring purposes, &c.; the roots are then dug up by large 2-pronged forks, cleaned, and dried, &c., at the factory. Large breadths of potatoes, black mustard, &c., are grown in this neighbourhood. The parishes of Kirton (including Kirton Skeldike, and running many miles westward from the sea to Kirton Holme), Frampton, and Wyberton (adjacent to Boston), contain much land of admirable texture, capable of any course of cropping. Nearer the sea are some capital sheep lands, and adjoining the Boston road there are bullock lands equal to any of the grazing grounds in the district.

Northward from Spalding are the parishes of Pinchbeck and Surfleet, the former chiefly fen, the latter possessing a considerable extent of good marsh. Stretching still further north are the parishes of Gosberton, Quadring, Donington, Bicker, and Swineshead: these towns and villages being in a line parallel with those mentioned above (viz., Algarkirk, Sutterton, &c.), and about 5 or 6 miles more to the westward. They contain fine grazing ground, with a portion of fen attached to them on the west. The soil of Bicker is much of it light and poor, having formerly been an estuary of the sea, called "Bicker-haven," the banks of which are still remaining; and in one place a rabbit-warren is still kept up. Between Donington and Kirton is Wigtoft, one of the richest in the whole district. Under-draining is gradually coming into practice throughout the *whole extent* of this country.

Deeping Fen.—Leaving now the marsh and highland districts, the first Lincolnshire fen which comes under notice is that called

"Deeping Fen," containing about 25,000 acres. The first Act passed for the drainage of this fen was in the reign of Charles II., A.D. 1661. This was done by means of windmills, a practice which has there continued until about the last 20 years. In 1801 an Act was procured for draining, dividing, allotting, and inclosing Spalding, Pinchbeck, Deeping, &c., Commons, comprising upwards of 13,000 acres, when two new drains were cut, called the "North and South Drove" drains; but the country still remained in a very wet state, so much so that within the last 40 years boats might in some places be rowed over the land. In 1823 another Act was obtained, and two powerful steam-engines were erected in 1824 and 1825 at Pode's Hole, about 2 miles from Spalding. The benefit of these engines, however, was not realized for some time after their erection, as the drains were insufficient for carrying the waters to them. The windmills were still kept up on the different farms until 1831, when all the internal drains were deepened about 3 feet, and a new one cut on the west side of the fen. There are now four large drains, having smaller ones uniting with them, all coming to one focus at the engines. There are two engines, one of 80, the other 60 horse-power, both under one roof, capable of lifting 300 tons of water per minute 7 or 8 feet high; the water is thrown into the Vernatt's drain, which empties itself into the Welland, about 7 miles from thence at the reservoir, below Spalding. The engines drain about 25,000 acres; namely, 10,000 acres called "Adventurers' Lands," 10,000 commons, and 5000 acres called "Free Lands" (besides which they have to throw out the great soakage of water from the rivers Welland and Glen), at a cost of about 5*s.* per acre on the former, and 3*s.* per acre on the free farms. There were formerly 44 wind-engines, the combined power of which amounted to about 400 horse-power, but there is not a single mill now remaining. It is expected that the improvements in the outfall of the Welland, which are now in progress, will give this fen a complete natural drainage. This, like all the other fen rivers, "falls into the great bay called the Wash, shallow and full of shifting mud-banks, through which at low tide it winds its shifting course into deep water." The river is now being carried in a straight channel out to sea in the following singular manner:—"Two rows of bush-faggots are laid perhaps 50 yards in advance on the mud, at low water, on each side of the river. After a few tides these faggot heaps are found full of 'warp,' a mixture of fine sand and mud, which renders them in some degree solid; another tier of faggots is then laid upon the first, and is again embodied with them by the warp." This kind of embankment is continued in a straight line over sand and through water, or across the old bed of the river, the faggots being sunk in the water and bedded in the soft mud by means of

earth, &c., thrown upon them out of boats. One row is always advanced before the other on that side which will most impede the current of the river; the tide, in coming up, overflows this weak fence, filling it with warp and making it so strong that the ebb water is unable to remove such an obstacle from its course, and is compelled to dig out a new channel through the sandbank in the intended direction. In this way the faggots are advanced, taking care to keep the "scour" side foremost, and a new deep channel is worn by the water. The works have now reached nearly 4 miles in length, and the land on each side the new river will be inclosed by cross-embankments, when considered high enough for the purpose.

The soil of Deeping Fen varies very much, though it is principally peat. At the south-western extremity, abutting upon the high lands of Baston, Langtoft, &c., is a small strip of gravelly soil; next, a breadth of about 3 or 4 miles stretching from the Glen to the Welland, is peat with a subsoil of blue clay; next comes a tract of peat having a silty subsoil, or lying upon a bed of red heavy clay, which is very good, and as an alterative renders the land very productive; nearer Spalding and along the river side is a dark loam, having mostly a clay subsoil, in some parts a silty subsoil, in others silt and clay mixed. Near the Welland is some good grass land, the soil being about a foot of alluvial deposit resting upon moor, no doubt formed by the overflowings of the stream. Near the western part the land consists of about a foot of black soil above 10 feet of blue clay, which rests upon gravel.

During the last 12 years hundreds of acres have been wonderfully benefited by "claying;" but now there is no need for claying with the spade, as the subsoil, both of silt and clay, is in most places ploughed up and mixed with the peat. In the year 1799 Arthur Young writes—"Twenty years ago the lands sold for about 3*l.* per acre; some was then let at 7*s.* or 8*s.* per acre, and a great deal was in such a state that nobody would rent it; now it is in general worth 20*s.* per acre, and sells at 20*l.* per acre." This great improvement was effected under mill drainage, and at a time when the system of paring and burning for oats, coleseed, and rye was in fashion; the same land now, in consequence of steam drainage and claying, has doubled in value, the average rental of Deeping Fen being about 35*s.*, and a great deal is let at 2*l.* per acre.

The rotation of crops is generally a four or five-field system, viz.—1st, coleseed (turnips, mangold wurzel, and carrots are exceedingly good, but coleseed is most common); 2nd, wheat; 3rd, clover or seeds; and 4th, wheat; or when oats are grown they are a last crop, thus, 5th, oats. Nearly half the fallow is sown to wheat, the other part is usually 2nd, oats; 3rd, wheat; 4th, seeds; 5th, wheat; when beans are grown, which is seldom, they are a first crop in the place of oats. Occasionally, to improve the land with grasses, the course is, 1st, cole-

seed, the surface being scarified or lightly ploughed the next spring and sown with seeds, which are grazed for two years, carrying about 12 sheep, and in some instances 20 sheep per acre for four months; next, 4th, wheat; 5th, beans, manured; 6th, wheat, also manured. The wheat grown is generally of a great weight, but not particularly fine in colour; the oats are good; beans are rarely grown; barley is being tried, but has not hitherto been cultivated with much success. The long-wool breed of sheep are most commonly grazed, but during the last few years many thousands of half-breds have been grazed on the seeds (one-third of which are usually mown), and then fattened on the coleseed.

The practice of all the best Deeping Fen farmers is, to manure for every acre of wheat they sow except that after coleseed; and a great many beasts are kept during the winter upon straw and large quantities of oil-cake, to enrich the manure. Great quantities of bone-dust, ashes, and bones dissolved in sulphuric acid, are used for the coleseed. To obtain the ashes the land is sometimes pared (with a newly invented plough, which may be adjusted to skim the surface as thinly as possible, one inch deep, or more if required) or by a cultivator, and burned in heaps, a portion of the black soil being consumed, and the clay forming a beautiful ash. Guano, rape-cake, and salt are also extensively used.

The principal part of Deeping Fen is well drained, but there are more than 4000 acres of low land lying across the south-western part, and west of the division of Holland and Kesteven, which, notwithstanding all the improvements, are yet imperfectly drained. The engines do not keep the water in the ditches lower, upon an average, during the winter season than 15 inches from the surface. The soil is therefore generally wet, and much of the manure soaks into the ditches; this great evil requires to be remedied, and it might be readily done by deepening the drains, and lowering the water-wheel of one (or both) engines: an improvement which might thus take out the water from the whole district, one foot lower, without any increase of power being required for the engine, as the recent improvements in the outfall have already lowered the "*head*" of water about 1 foot. There is a private engine on this low land, which kept the water on one farm during last year 2 feet lower than on those around, and consequently the crops were better and more equable. Immense quantities of water are taken in from the Welland in the summer, to water the fen: a practice which greatly hinders the work of drainage, and injures the channel of the river by causing a deficiency of backwater for scouring, &c.

Crowland and Cowbitt Washes extend about 5 or 6 miles along the east side of the Welland, varying from a quarter to three quarters of a mile in breadth, and contain upwards of 1500 acres.

These Washes, like Whittlesey Washes, which contain 3500 acres, are mown when the season is dry enough, producing some most excellent hay, but are often covered with water 6 or 7 feet deep. *This* reservoir is not needed; and if the passage of the river were better through Spalding, or a new cut made behind the town in order to ease the river, or perhaps the mere embanking of the Washes might suffice, the upland stream would force its own way through, and thus deepen and improve the river and outfall, leaving a breadth of good land to be brought under the plough.

Within the last seven years some small extent of under-draining has been done, both with tiles, thorns, and even stubble, with good effect. The drains (on the higher lands,—the low lands are some of them partially done in several places, but have a bad outfall) are generally about 30 inches deep, straight across the field, the distance apart being regulated by the retentiveness or friability of the soil. This operation has proved of great benefit on the higher peat soils, taking away the water, keeping the surface dry, and leaving the moor more compressed and solid, which is so necessary to the production of corn and seeds. Within the recollection of most farmers this district, now so much improved by artificial means, was under water during the winter months; but with the assistance of wind-engines and a tolerably dry spring, they could manage to sow oats by the end of April, though the greater part was not sown before the middle or latter end of May. The aspect of the country was at that time wretched indeed, with bad roads, miserable houses and farm buildings, and the land almost covered with water; now there are comfortable houses, a good turnpike road, excellent farmsteads, and a beautiful church in the centre.

A little below Pode Hole is an engine of 20 horse-power throwing into the Vernatt's drain, draining a district called Pinchbeck Fen. This contains about 1700 acres, lying north of Deeping Fen,—a small district and very expensive tax, yearly about 4*s.* or 5*s.* per acre. The soil is a shallow loam with a subsoil of silt, but yields fair crops of coleseed, wheat, and seeds, few beans being grown.

The parish of Spalding, with part of Pinchbeck, is drained by a steam-engine of 20 horse-power, throwing into the "Blue Gote" drain. This district runs up to the reservoir, but though so near to the sea, it was very wet, until the engine was built in 1832, and great numbers of sheep caught the rot; it is now a beautiful district of good rich land, of clay and silt, containing between 4000 and 5000 acres.

Black-Sluice Drainage.—Northward of Deeping Fen, and divided from it by the River Glen, is a tract of fen, called the

"Black Sluice drainage" district, stretching about 18 miles northward, and varying from one mile to 4½ miles in breadth. This tract, containing about 35,000 acres, lies between the high marsh lands and the hills, being bounded on the east by the Old Hammond Beck (a drain dividing it from the high lands), and by "Holland Fen;" and on the west by the "Carr-dike," an immense Roman work, which is supposed to have served for preventing the living waters from running down upon the Fens, and skirting the whole of them from Peterborough to Lincoln, afforded a navigation of the utmost consequence to this fertile country. This district was originally drained by the Earl of Lindsey in the time of Charles I., having its outfall at Bicker Haven and Risgate Eau; but the Adventurers' works (as before observed) were destroyed, and their lands again became a waste. Of late years, however, they were again drained, the principal outfall being by Langrick Sluice into the Witham. By the Witham Drainage Act, passed in 1762, the northern portion of this tract was taxed; but instead of receiving any benefit from the new cuts, their sluice was taken away, thus obstructing their drainage altogether. A new Act was therefore needed, and in 1765 one was obtained, under which the South Forty Feet drain was cut (some parts of it being only the old drain improved), which runs from the Glen Bank, up the middle of the fen to Holland Fen, through which it runs eastward to Boston (taking in the waters of another new drain—"the North Forty Feet," in Holland Fen—and the "New Hammond Beck"), and pours through the new "Black Sluice" into the Witham. In 1770 this drain was made navigable; and it is now an important means of communication between the Fens and the port of Boston,—being about 24 miles in length, and running up to the Glen bank, over which goods, &c. are carried, and conveyed thence to Bourn, &c., by the river.

An Act was passed during last Session, for making a still further improvement. Under the superintendence of Mr. Cubitt, the South Forty Feet is being made 7 feet deeper, a new sluice will be erected at the outfall, and the Hammond Beck made a good drain, which is expected to provide the whole district with a natural drainage. There are 65,000 acres (including several fens not yet adverted to) of taxable lands which drain by the South Forty Feet; besides many thousand acres which drain by it, paying no tax. This drain divides a number of small fens, belonging to the adjacent villages on the hill, from the fens attached to different marsh villages on the east. These are drained by about 63 windmills, principally on the west side of the Forty Feet, part of the land having a natural drainage; and those parts under mill drainage are not very low, the "head" being small—about 1 to

4 feet. The soil of Bourn Fen is peat, with a clay subsoil; but having been badly drained, the black soil has remained very deep. A steam-engine has lately been erected at a place called "Guthram Gote;" but great opposition was carried on by the Black Sluice commissioners, so that an immense sum of money was expended in draining about 4600 acres. A 30 horse-engine throwing into the Forty Feet, now drains well this district of very wet land, subject to a breach of the Glen Bank, which generally destroyed the crops. Previous to this improvement, it was not well managed; but now that the farmers have a better security for the outlay of their property, great improvements are going forward in "claying," and extra management generally.

Morton Fen is of a similar description, but more northerly than this the soil becomes a deep black loam; and the farms are still subject to the ruinous system of wind drainage. The soil of Pinchbeck North Fen, Surfleet and Donington, &c. Fens, is of a loamy nature, consisting of a mixture of clay and moor, with a strong clay subsoil. The low lands are drained by wind-engines, and therefore liable to be flooded at certain periods. The country is principally arable, well planted with thriving quick-hedges, and is in a fair average state of cultivation; having been in an improving condition for the last few years, but still capable of much greater improvement by underdraining, which is not practised to any great extent. Paring and burning is almost an obsolete custom, and claying is not required on this soil, as it already contains a sufficient quantity of clay. Perhaps the more general rotation of cropping pursued throughout the whole of this district is a four-field system,—the fallow being coleseed, then a white crop, next seeds or beans, and after that, wheat. Bones are found to answer well on the higher lands, but artificial manures are not generally used.

Westward of South Kyme Fen (the most northerly of the district just described), and the Carr-dike, is another breadth of fen, called by the Witham Drainage Act the Fifth District. Anwick Fen, containing 1097 acres, was drained and inclosed in 1792, before which there was no road across it, and the whole rental amounted only to 54*l.* The inclosure, however, raised the annual value immediately to 703*l.*, and it has now become excellent land. The moor is 3 or 4 feet deep, and most of the land has been clayed. The drainage is still by windmills. In North Kyme Fen there are a great many mills here of Dutch construction, these fens having been drained by the Flemings more than a century before the inclosure of Anwick Fen.

There is a great variety of soil in the "Fifth District,"—clay, gravel, and peat, with a subsoil of both. The fens on the east of the Carr-dike are better and higher land than those on the west (including Anwick Fen, &c.); and but a small portion has been clayed,—there being no need for such an operation, as a great part of the black soil has been "lost" by burning, tillage,

&c., and the remainder mixed with the clay by ploughing, before the process of "claying" was generally known. The old system of farming was to pare and burn for coleseed, and then take three crops of oats in succession, after which the land was laid down for grass a number of years, and pared, &c., again. Coleseed is not grown now upon the clayed land; turnips are the general fallow crop; good seeds are grown, being for the most part grazed; no beans, and very few oats are sown, wheat being the principal crop, and yielding on an average about 4 qrs. per acre. These fens are on a low level and not well drained; but still many of the farmers have commenced underdraining; it is, however, to be feared, that little benefit will ensue until a better outfall for the hollow drains is provided, by means of a better system of drainage.

Separated from this district by the high lands of Billinghay and Walcot, is a long reach of black land, called the "First District," in the Witham Act. It stretches about 20 miles,—from Lincoln to Kyme Eau. It varies in breadth from about 4 miles at the southern extremity, and about 3 miles most of the way up, to only half a mile towards the northern limits at Lincoln; and contains upwards of 25,000 acres.

In the middle of the last century these fens (being now divided into nine or ten districts, belonging respectively to each of the villages on the neighbouring hills)—by the inundation of the Witham, were a perfect sea; and it is a remarkable fact that no longer than 60 years ago, a *thousand* acres in Blankney Fen—(now one of the richest districts)—were let annually by public auction at Horncastle, the reserved bid being 10*l.* The first Act passed for embanking and draining this waste, was in 1787 or 1788; and during the inclosure, the Commissioners sold portions to speculators at 14*l.* per acre: these were cropped immediately for 3 years with oats, *each* crop making more than the purchase-money; and thus, by improved drainage, multitudes of individuals—not only in this, but in every part of the Fens,—have realized their fortunes. Through a senseless opposition, an extent of a mile in breadth, the whole length of these Fens, was left outside the embankment,—lest the waters should be too confined, and the other side of the river be overflowed. This screed of land bordering the Witham was called the "Dales," being a "wash" or reservoir open to the river and overflowed—like the rest before inclosure—for 9 months in the year; and windmills were erected to throw out the superfluous water from the fens into the "dales." But the mistake was soon perceived, another Act was obtained, and this breadth was embanked, partitioned off as frontages to the different fens, and an additional mill built to drain each. This district consists of a number of fens, reaching in long narrow slips

between the hills and the river, the partitions being main drains for conveying both highland and fen waters to the river; into these drains the mills threw their waters, and the "head" not being high "double-lifts" were not required. During the last 6 or 7 years, every one of the mills has been pulled down, and steam-engines erected in their stead. Nearest to Lincoln is Heighington Fen Engine; the next is Nocton Engine, the *first* that was erected in these Fens, and the most powerful; next is Metheringham Engine, of 20-horse power; then Martin Engine, of 30-horse power, which drains Blankney Fen; next to this is Timberland Engine, built in 1839; and there are several more,—every separate fen having its steam-engine. Near Tattershall Ferry Bridge, at the south extremity of these fens, is a powerful engine which drains a very large tract, left at first uninclosed, called "Billinghay Dales," and also a part of North Kyme Fen. At the village of North Kyme, the two divisions of the fen belonging to it—the part under steam drainage, and that drained by wind—meet in a narrow neck of fen land between two ridges of high land; thus forming a connection between the "First District" now under consideration, and the "Fifth District," or *basin*, already described. The drainings, however, are quite distinct, a barrier bank being constructed across this opening, to secure one side from the floods which may desolate the other. On the opposite side of the Witham is a tract of fen land, called the "Third District" in the Witham Act, which runs in a narrow "reach" along the river from the high lands of Willingham, near Lincoln, to the River Bane, near Tattershall. In this district, which is only of small area, steam-engines have also been erected; the Bardney Engine of 30-horse power, draining Stixwould Inclosure—a "wash" recently embanked; the Kirkstead Engine, &c.; and there is also *one* windmill at Chapel Hill, near Tattershall Ferry Bridge—the sole survivor of all the numerous mills, which once held both districts under the fickle and often disastrous influence of the winds.

In consequence of the inclosure of the "dales," &c., on both sides of the Witham, when the pressure of upland water—(descending from beyond Lincoln, Grantham, &c.)—is great, and there is also a heavy downfall in these fens, there being no reservoir for the waters beyond the river, and the various intersecting drains—there is a great danger of a breach in the banks. And this sometimes occurs; last year one bank gave way, but was fortunately repaired before any great damage was done; so that some improvement is needed in the great outfall to sea. The water is held up by a great sluice at Boston, for the convenience of navigation. Thus in fact the necessity for an expensive artificial drainage has been artificially created; and by some it is expected,

that, as railroads will ere long become the chief modes of transit, the river being no longer needed for vessels, the sluice may be removed, and these Fens will acquire a *natural* drainage.

The soil of the "First District" is peat, upon a whitish silty clay; the depth of moor varying from 8 inches in the southern parts, to 5 or 6 feet, nearer Lincoln. The usual depth is about 8 inches of decomposed vegetable matter; then a foot of moor, upon 12 feet of clay; and underneath that is about one foot of soil similar to the surface, mixed with branches of trees, &c.; beneath this there is one foot of sand; and lastly, a bed of clay of quite a different character to the upper stratum, being yellow, and very strong and tenacious. The whole of the surface is black land, extending even a little beyond Lincoln; and there is also a small breadth of it on the east side of the river. Claying has been done *once* on nearly all these fens, but not many fields have been done twice. It has been the usual method to make the "dikes" four yards apart, and sometimes only two yards apart, and one or two feet wide, the clay being taken out one "draw" deep. This practice, combined with the improved drainage, has wonderfully augmented the value of the land;—Blankney Fen (before referred to as worth little or nothing) is now worth 60*l.* per acre, and the whole of these fens, which are all exceedingly well drained, fetch a high rental—the worst letting for 25*s.*—the principal part for 35*s.*—and the best for 2*l.* per acre. In Metheringham, and some other Fens, there is a narrow skirt of black soil which has a gravelly subsoil, being thus inferior land, but has had clay carted upon it with good effect. This is rather northward; and as a general rule, these fens improve in quality the further they are south;—each district being better than the next above it.

These fens have, generally speaking, been badly managed; being chiefly occupied by farmers who live on the neighbouring high lands; and their straw, mown seeds, &c., have been carried off the fen to the upland farms, no manure being returned beyond the few bones sown with the coleseed. But there are many superior managers who consume their straw, &c., on the fen, giving their beasts a good quantity of linseed oil-cake, during the winter. The old system was to tear up an immense quantity of the black earth into heaps, with an implement called a "bob," and then burn it, the ashes making a manure for coleseed; after this, one or two crops of oats were taken, and the land laid down to grass for 3 or 4 years; and thus the surface has been lowered several feet. There is no regular course of cropping pursued, but a six-field system is much approved of; thus—1st, coleseed; 2nd, wheat; 3rd, seeds; 4th, wheat; 5th, oats; 6th, wheat. About two-thirds of the seeds are grazed, with sheep of the long-wool breed; and

may be noticed, that whenever the seeds are eaten off so as to leave the land bare, the following wheat crop is always very much injured. The land is very subject to "honey-comb," and as a preservative against its ill effects, a new plan has been lately tried, which keeps the soil solid and unparched by the sun, and its requisite moisture unabstracted by the wind. By means of a drill, made with coulters similar to the tines of a scarifier, the wheat is sown upon the coleseed stubbles without ploughing (and thereby lightening) the well-trodden and compressed surface. This simple method of wheat-sowing after a fallow crop is quite new; but the trials already made have proved entirely successful,—the crops thus sown having been stronger and finer than any others. Underdraining has been practised only in the lowest and wettest parts of the fields, in places where top-gripping (which is not generally done) was found necessary. A great many quick-hedges are being planted, which will be a great improvement to this country; a trench about 3 feet wide and 2 feet deep is dug round the field (thus taking out the obnoxious stratum of moor), and is filled up again with a mixture of clay and peat soil, in which the quick grows exceedingly well. Upon the whole, very little oil-cake is used in these fens; but about 12 bushels of bone-dust per acre are usually sown with the coleseed, any other kind of artificial manure being rarely used.

South-eastward of this long range of fens is "Holland Fen," called by the Witham Act the "Second District." It is bounded on the north-west by Kyme Eau; on the west, by South Kyme and Heckington Fens; on the south, by the "Hammond Beck," which separates it from the parishes of Swineshead and Kirton-holme; on the east by Boston, and north-east by the river Witham, from near Boston to Tattershall Ferry-bridge.

This fen, containing 22,000 acres, was drained and inclosed under the Black-sluice Drainage Act in 1765; before which period it was an open common, stocked by persons who claimed a right, belonging to the eleven towns of Holland. *The rental before inclosure was* 3600*l.*, *but directly after, it let for* 25,300*l.*, *and is now most beautiful and valuable land!*

The drainage is a natural one by the Hammond Beck, the North Forty-feet (which lies wholly in this fen), and other smaller drains, uniting with the South Forty-feet, which empties itself into the Witham at Boston by the Black Sluice. This is an excellent drainage; but will be still further improved by the works that are now in progress for the benefit of the low lands near Bourn.

The soil of Holland Fen is a fine loam, having a subsoil of clay, with a mixture of silt. The most general mode of management on the best lands is a five-field system; on the inferior, a four-field system. The greater portion is sown with wheat; the

remainder with oats, beans, coleseed, and turnips, with a small portion of barley.

A great deal of oil-cake has been consumed for the improvement of the yard manure; and bones, lime, salt, and ashes have been used to a small extent, all of which have proved to be very beneficial. Very little underdraining has been done at present, but there is every likelihood of its becoming general in a few years.

Arthur Young, in 1798, mentions a farmer at Brothertoft (in this fen), who, " before the draining and inclosure, paid 20*s.* rent for a *cottage* and *croft.* His stock on the fen was 400 sheep, 500 geese, 7 milch cows, 10 or twelve young horses, and 10 young beasts. Such a person, if ever one was heard of, must have been injured by an inclosure ; for never could be known a more perfect contrast between the rent and stock of a holding. But he now rents about 50 acres of the inclosure at 25*s. an acre,* and greatly prefers his present situation, not only for comfort, but profit also." And since that prodigious increase in the value of this land it has still been progressing, letting now for upwards of 2*l.* per acre, and producing abundant crops of corn and pulse.

Wildmore Fen and West Fen.—On the opposite side of the Witham from Holland Fen is " Wildmore Fen," and further eastward is " West Fen ;" both of which form one district of soil so similar in every respect that they may be both noticed together. This tract is bounded on the south and south-west by the Witham, from near Boston to Tattershall Ferry-bridge; on the north-west by the highlands of Tattershall, Coningsby, Tumby, Mareham, and Revesby; and on the east by the high grounds of Stickford, Stickney, and Sibsey; forming part of the " fourth district," taxed by the Witham Act. These fens—after the attempted drainage already noticed in an earlier part of this Report—were under the superintendence of a Court of Sewers, the drainage being principally carried on by means of the Adventurer's drains; but the river Witham being neglected and nearly silted up, they became so much oppressed, that application was made to Parliament in 1762, when the Witham Act passed, by which a number of drains were made sufficient to carry off the downfall waters only—the upland waters still pouring down upon the Level, so as to render the inclosure of it impossible. Another Act was therefore procured in 1801, for more effectually draining these fens; and another division of this district, called the " East Fen," was incorporated with the " fourth district." Some new drains were executed under the direction of Mr. Rennie, a catch-water drain was cut round the base of the highlands, and a proper outfall provided to carry the hill waters separately to sea, thus draining a tract of 40,000 acres.

Prior to inclosure, both West and Wildmore Fens were open commons, stocked by the freeholders of the surrounding parishes in the summer with horses, beasts, and sheep; but generally covered with water during the winter months. Upon driving West Fen in 1784, there were found 3936 head of horned cattle; and in dry years it was perfectly white with sheep. Arthur Young states that "in 1793 it was estimated that 40,000 sheep, or one per acre, rotted on the *three* fens. Nor is this the only evil, for the number stolen is incredible: they are taken off by whole flocks; as so wild a country (whole acres being covered with thistles and nettles, four feet high and more) nurses up a race of people as wild as the fen."

The drainage of West Fen, containing 16,924 acres, and Wildmore Fen, containing 10,661 acres, has been successfully accomplished by several large drains, which all empty themselves by one outfall into the Witham, near Skirbech Church, a little below Boston, and are kept in order by the Witham Commissioners, who levy a tax of 2*s.* per acre on the whole district for that purpose. The two fens are also intersected by numerous small drains, or sewers (all emptying themselves without the aid of any engines whatever), which are under the management of the "fourth district" Commissioners, who also levy an interior-drainage tax of generally 6*d.* per acre for cleansing them out.

The soil of the West and Wildmore Fens is most of it a rather stiff clay, with an admixture of silt, having either a silt or clay, and in some parts, a gravelly subsoil; and a small portion of the lands adjoining Revesby, Mareham, Tumby, and Coningsby, consists of a subsoil of gravel, covered by a top soil mixed with sand. Underdraining has been carried on to a considerable extent; scarcely any large occupier omitting to do some, and many of the farmers are doing a great deal. The drainage of these fens is so complete, that a good *fall* is obtained for the hollow drains; and the results have hitherto been all that could be desired. The drains are generally made 10 yards apart, and about 2½ or 3 feet deep; the object being to reach what are called the "cold springs,"—that is, springs of water rising through the silt at about two feet depth.

Wedge or sod draining has been tried, but proved unsuccessful in consequence of the lightness of the silty subsoil; round pipes, fitting together in "caps," or collars, are becoming very general; but tiles and soles have, as yet, been by far the most common.

Nearly all the land is arable, there being merely a few fields of grass land scattered throughout these fens; in Wildmore Fen there is but *one* patch of grass which equals 100 acres in extent, the rest being all in isolated pieces near the farmsteads.

It would be difficult to give a correct statement of the varied rotations of cropping, arising from the great difference in the soils, &c.; but perhaps a five-field system prevails generally on the clay soils, and a four-field system on the sands:—1st, coleseed, (a few turnips occasionally); 2nd, wheat; 3rd, seeds, about half mown, and the rest grazed with long-wool sheep; 4th, oats or beans; 5th, wheat. Some plough up their seeds for, 4th, wheat; 5th, beans; and then, 6th, wheat again. On the gravelly, or sandy soils, the following "wold" system is adopted:—1st, turnips; 2nd, oats or barley; 3rd, seeds; and 4th, wheat. The clay land is generally ploughed into 8 feet "lands," which is requisite to keep it dry, the clay being so stiff and retentive that water remains on the surface wherever a horse sets his foot. It will produce excellent turnips, and good crops of clover and ryegrass; but the seeds must be always got after a first crop.

Artificial manures are not used to any great extent, it being found that linseed cake given to beasts in the foldyard during the winter is the most economical and beneficial method of improving the strong clays; whilst bones, in addition, are used partially on the sands.

These fens, when stocked by the commoners with horses, cattle, sheep, and immense numbers of geese, were worth comparatively nothing; but a few years ago land was bought at 25*l.* per acre, and is now (in both fens, though Wildmore has a portion of poor land which makes it altogether not so good as West Fen) selling for 60*l.* per acre. Since the inclosure, two new churches have been built in Wildmore Fen, and two in West Fen, the land being divided into as many parishes. The whole country is now well planted with neat quick-hedges, which are kept under the hook; the land is for the most part well farmed, and agricultural improvements generally are being carried out to a considerable extent.

The highlands of Sibsey, Stickney, and Stickford, which divide the "West" from the "East Fen," are an excellent range of stiffish clay soil, upon a yellowish clayey subsoil. About three-fourths of this tract is under-drained; the principal part is arable, usually managed on the four-field system; but there is some good grazing ground about the villages, much of which is not surpassed.

The East Fen.—The "East Fen," a tract of 12,424 acres, is entirely separated from all the other fens. The soil of the marshes, extending along the coast from Boston, through Frieston, Butterwick, Bennington, Leverton, Wrangle, Friskney, Wainfleet, &c., is a rich dark loam of admirable texture; and near the fen there is a breadth of very stiff blue clay. This tract of marsh contains some of the richest grazing lands in the kingdom, which are "the glory

of Lincolnshire;" the soil of the best pastures being a black mould, or mass of vegetable particles. The long breadth of land between the boundary of the Wolds and the sea, bounding the East Fen on the north-east, and running up to the Humber, is called the Marsh and Middle-marsh; the former a rich marine clay and loam, the latter a line of strong soil called "the Clays," lying between the Marsh and the Wolds.

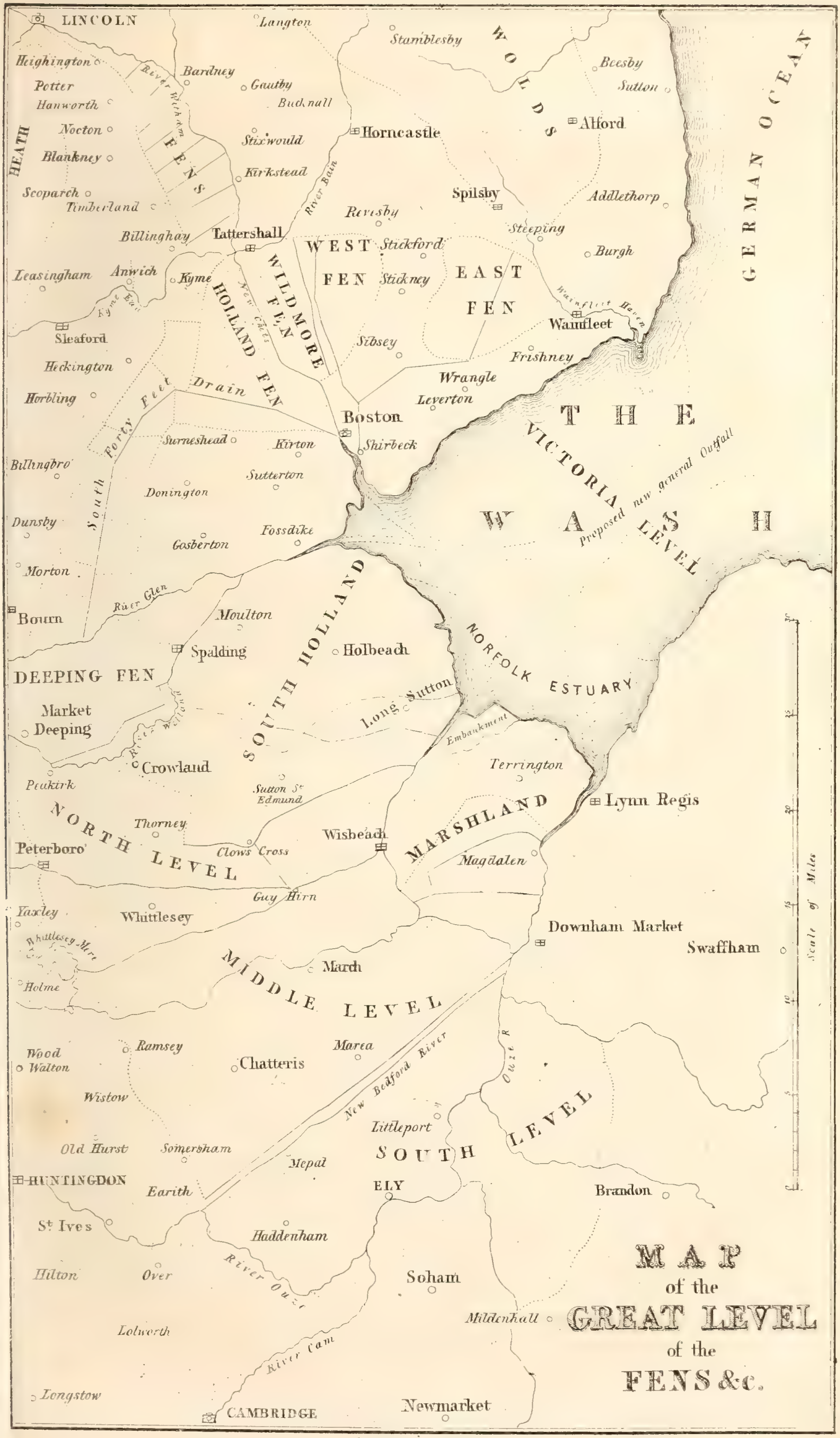
The East Fen, being on a lower level than the West and Wildmore Fens, and the natural course of their waters to sea being through it to Wainfleet Haven, was in a far worse condition than the other districts, previous to its drainage. About 2000 acres of it were continually under water, from four to six feet deep, standing in pools from 60 to 600 acres in extent; and a great part of the remainder was a shaking bog. The whole of this desolate region had the appearance of a chain of lakes, bordered by great crops of reed, abounding in fish and wild fowl. There were a great many "decoys," in which were captured thousands of wild ducks, widgeon, and teal; and one portion of the fen belonging to Friskney was denominated the "Mossberry, or Cranberry Fen," from the immense quantities which grew upon it.

This fen was drained and inclosed under the Act of 1801, when a large drain was cut through the heart of the district—from the base of the Wolds below Toynton to the outfall at Hobhole near Frieston—by which the natural drainage of the whole has been effected, and an invaluable medium of communication between the interior and the sea has been also provided by its navigation. About 1*s.* per acre drainage-tax is paid to the Witham Commissioners, and from 4*d.* to 6*d.* per acre for the management of the various interior drains; the fen being pretty well drained, and not subject to overflow.

The soil is peat upon a subsoil of blue clay; thus forming a perfectly detached district of fen, similar to the black lands before described. In surveying for the East Lincolnshire Railway, bores were sunk at every mile across the fen, and there were found to be from two to three feet of moor, in which immense trees and roots have been discovered; then a subsoil of good blue clay, varying from 6 to 19 feet in depth; next a thin bed of white marl, and beneath that gravel. The fen has all been clayed three, and part of it four, times; the trenches being generally at intervals of from 7 to 12 yards, and the clay is taken out three feet wide and two feet deep at a cost of 1*s.* 8*d.* to 2*s.* per chain, or about 3*l.* per acre. There is a small part of the district which has a sandy subsoil, and has been dressed with clay, carted upon it from adjoining lands. This fen is nearly all arable, there being scarcely any old pastures left; but no underdraining has been done upon either.

The general rotation of crops is 1st, coleseed; 2nd, oats; 3rd, wheat, sown with, 4th, ryegrass, which is grazed or mown, and then *pared and burnt* for coleseed again, or else for—1st, turnips; 2nd, oats; 3rd, wheat; manured for, 4th, beans: but beans are not *very* generally sown. Wheat sometimes follows coleseed, when it is intended to lay down seeds (Timothy-grass and small seeds) for a few years; and the land is occasionally laid down for grazing without a crop. The produce is usually for oats, about 7 to 10 quarters; and wheat, from 3½ to 5½ quarters per acre; beans are very precarious. Swedes and a few white turnips are grown as well as coleseed, though not to half the extent; the swedes are sometimes used in the fold-yards with straw and oilcake for the beasts, of which there are many wintered, eating from three to six, or even seven, pounds of cake per day. Very little artificial manure is used, but the *best* fen farmers purchase a great deal of what they call "Boston manure," such as night-soil, mussels, ashes, soot, and a little lime, besides a large quantity of bones and sulphuric acid.

I have endeavoured thus to give a general outline of the history and condition of this Great Level, tracing its successive transmutations, from being one vast bay of the sea with a surface chequered by numerous islands, to a boggy wilderness; and its change, after the commencement of the drainage by the first adventurers,—into a region of wild and swampy country partly cultivated, and partly overflowed, "by which overflowings," says Dugdale, "in the winter time, when the ice is strong enough to hinder the passage of boats, and yet not able to bear a man, the inhabitants upon the hards and the banks within the Fens, can have no help of food, nor comfort for body or soul, nor supply of any necessity, save what those poor desolate places do afford. And what expectation of health can there be to the bodies of men, where there is no element good? the air being for the most part cloudy, gross, and full of rotten harrs; the water putrid and muddy, yea, full of loathsome vermin; the earth spongy and boggy, and the fire noisome, by the stink of smoky hassocks." And thence, in the progress of its drainage, have been noticed the works for improving the outfalls of the great rivers and the improvements in the interior drains; and lastly, its final change, by the introduction of steam-engines, into the present fruitful and salubrious country. A rapid survey has been taken of the various districts,—noticing the richness of their soils thus regained from the waters; the extreme verdure and beauty of their pastures; the abundance and luxuriance of their crops of grain, pulse, roots, and seeds, upon what in former times were drowned lands; the advantages resulting from the navigation of the leading drains, for the carriage of this corn and merchandise; the extensive works of drainage, drains, sluices, banks, &c.; the method of keeping tens of thousands of acres dry, by raising the water from the low lands with windmills and steam-engines,—there being about



Standidge & Co. Litho London.

250 mills, and between 40 and 50 steam-engines (some of them of gigantic power), which are exerting their immense force for the benefit of agriculture; and still further, the improved value of the land from being worth comparatively nothing to its rank now amongst the first class of soils; the vast outlay of capital in claying and the use of artificial manures, and the consequently enormous increase in the products of cultivation, and the augmented supply of food for millions of the people. And now, in conclusion, it is greatly to be desired that other fens should be improved, that other wastes should be brought under culture, and other bogs and swamps reclaimed. With such a noble example of the success and profit which have attended the triumph of enterprise, the achievements of skill, and the acquirements of industry, in a work which,—not satisfied with laying dry the fertile beds of lakes,—contemplates and progresses in the undertaking of raising a territory, yet unformed, from the hidden depths of the ocean;—with so magnificent an example as this to animate and encourage; surely the agriculturists, in the neighbourhood of bogs and fens, will not allow them to remain much longer in their present wild and uncultivated state? Surely, in this age of enlightenment, and especially in this time of necessity, prejudice for old customs and circumstances—which proverbially appertains to the character of a farmer, and notoriously so to that of a fenman—will not be permitted to impede so important an improvement;—surely, the much needed work of draining and inclosing the wastes and morasses of England will not be abandoned because the present class who own or occupy them declare that water is necessary to make such tracts bear produce; and that if thoroughly drained and dried, the soil will become infertile and useless! Such were the assertions and expostulations of the fenmen in the Great Level,—but despite their predictions, this region (which was once "wholly overwhelmed with a deluge of waters," and afterwards came to a similar condition with the present swamps of England) having an area of 680,000 acres, equal to that of the "Low Countries," has been made into a most fruitful plain, yielding vast stores of produce, enriching thousands of individuals, furnishing multitudes of population with food, and adding greatly to the wealth and resources of the empire. This has been accomplished, and it cannot but follow that ere long all the waste places in the land which are cultivable, will in like manner—in the face of every difficulty—be compelled to manifest their capabilities of production, and assist in replenishing the storehouses and supplying the necessities of the people!

VIII.—*Report on the Analysis of the Ashes of Plants.* (Second Part.) By J. Thomas Way, *late* Professor of Chemistry at the Agricultural College of Cirencester; and G. H. Ogston, *late* Assistant to Professor Graham, of University College, London.

In presenting our last report to the Society, we found occasion to remark that circumstances rather than choice had led us to make the cereals the first objects of our attention. In anticipation of the harvest, we were enabled to make arrangements for collecting specimens of wheat from different soils and localities, and the result of their examination was communicated to the Society. With wheat, we think, enough has been done for the present. Of the other corn crops, however, we know but little, nor are we at the present time in possession of a selection of specimens either of oats or barley, that would repay the outlay of much time or labour.* We hope in the coming autumn to obtain satisfactory samples of these crops; but in the meanwhile it is our duty to lay before the Society the results which we have obtained respecting the more important of the root crops. On the whole, there can be little doubt that this branch of the subject is of more consequence than any other. It has been justly remarked, that the turnip culture is the basis of all good farming; it is the means, in the hands of the intelligent farmer, of bringing his land into a condition of cleanliness and fertility, and in the rotation the crop is invaluable, both as a source of food for the manufacture of mutton and beef, and as a preparation for the succeeding corn-crop. The necessary conditions of the growth and the peculiarities of the mineral composition of the turnip and the root crops generally, must therefore be of very considerable importance and interest, and should hold a prominent place in the research with which our attention is at present occupied.

We have said that the root crops are means, when judiciously employed, of increasing the fertility of the land—of rendering it, that is, capable of bearing larger crops of the more valuable produce, wheat and the other cereals, which form the great staple of food for man. Now, how do they effect this? Whence the efficacy of the turnip and the mangold? What peculiar properties do these roots possess, that their cultivation should form so important a feature in modern agriculture? They are most powerful, most industrious agents in the collection and preparation of

* With the exception of a series of specimens of barley grown by Dr. Daubeny with different artificial manures, the analysis of which we had hoped to complete for the present report.

food, both mineral and vegetable, for the use of other crops. They are continually employed, abstracting by their leaves from the air the constituents of which their own vegetable substance is made up. They never cease to collect by their roots, and to bring to the surface the mineral matters which are essential to their own growth, and to that of the crops which follow them—and both these forms of matter, the organic or vegetable, and the inorganic or mineral are (when the crop has been consumed by sheep) in great part left in the soil in the condition most favourable for the purposes of the succeeding plants. It is chiefly, however, to the accumulation of vegetable matter, that we are to attribute the influence of the root crop generally in improving the soil; for although the turnip does certainly add to the available stock of mineral ingredients of the surface soil, its own growth is very mainly dependent upon the sufficiency of their supply, and to obtain a very liberal return we must be proportionately liberal in our grants of the materials which are indispensable to the construction of the crop.

Root crops, from the great development of their gas-collecting leaves, are *comparatively* independent of the soil for vegetable nourishment. They may in reality add to, rather than take from the quantity of vegetable matter in the soil, even when entirely removed—for land has been found after several years' cropping with turnips, all the produce being carried off, absolutely richer in organic matter than it was at first, the plant having returned to the soil more than it had taken from it.* How much more is this the case when a large portion of the organic matter, after passing through the body of the sheep, is returned in a highly comminuted state to the land.

It cannot, however, be too often insisted upon, that, whilst we may fully restore by a green or root crop all the organic wealth of which the soil has been deprived by the grain of a crop of corn, we have no such resource for a renewal of its mineral ingredients. The phosphoric acid, the potash, and the magnesia of a plant must be obtained from the soil, and the soil alone. But even in this respect much may be done; it may be safely pre-

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* See Dr. Daubeny's 'Memoir on the Rotation of Crops.' So little is known with regard to the excrementitious matter of plants that we do not lay much stress upon this argument. There is little doubt that in the circulation of the vegetable juices in plants there is a continual ejection into the soil of matters not required in the economy of the plant; but whether the amount thus voided can at any time exceed that which is taken in by the roots we have scarcely sufficient evidence to decide. It is extremely likely that in broad-leaved plants of rapid growth this result may occur; but of the increase of organic matter in a soil where the green or root crop is eaten off or ploughed in, there is not a shadow of a doubt.

dicted that a time will come when, in the cultivation of land already brought into a state of high fertility, the application of artificial manures, except in rare cases, will be looked upon as an unnecessary and unjustifiable waste of money. At the present stage of agricultural practice, the only *necessary* loss of its mineral ingredients which the land sustains, is comprised in that portion which is sent into our large towns in the different grains and in the bones of animals, and that other small (but unfortunately often too considerable) portion which is lost by the drainage of liquid from the stables and manure heap. The purchase of bones to restore the phosphate of lime removed by the growing by sheep and the milk of the cows, should hardly perhaps be looked upon in the light of the application of artificial manures, because nothing can be more reasonable than to give back what we have taken from the soil; and the measures now in progress for rescuing the sewage of our large towns, and an improved system in the manufacture and preservation of natural manures at the homestead, will leave but little on the credit side of the land. But allowing a certain and considerable yearly diminution of the mineral elements of fertility in land, we have yet, so to speak, an almost infinite supply of these bodies in the soil itself, provided we knew how we might economically avail ourselves of it. This (the item of *expense*) is after all, the turning point—most soils, if sufficiently exposed by repeated stirrings and cultivation to the action of the natural agents, water and air, would yield up abundant materials for the growth of luxuriant crops of roots, and through their means of corn.

We know from the constitution of the rocks from which they have been produced, that all soils containing any clay, must contain also considerable quantities of potash; and there is every reason to believe that no sandy or chalk soil is absolutely deficient in this alkali. Again, the experiments of Dr. Daubeny and Professor Fownes have led us to believe that phosphoric acid is a constituent of the chalk and limestone strata, as well as of the older rocks; and the recent investigations of Dr. R. D. Thompson * and of Mr. Sullivan,† go a great way to prove that this acid, so important to agriculture, is present in all the great mineral masses of the globe, whether of ancient and igneous origin, such as granite, gneiss, and all volcanic rocks, or the more modern aqueous deposits of which so large a portion of the soil of England consists. The presence of phosphoric acid in the older rocks is however the important point, because its existence (as insoluble phosphate of lime) in the sedimentary deposits

* 'Philosophical Magazine,' xxvii. p. 310.

† Ibid., p. 161.

formed from the débris of the first, follows almost as a natural consequence. But though it is quite possible that from the universal prevalence of the most important mineral constituents of crops, sufficient working of the soil would enable us to dispense with the addition of any artificial manures—it may be, and is, far more economical at the present time to supply the requisite dose of mineral matter directly, than to seek to furnish it from the natural resources of the soil by a costly expenditure of mechanical force. It must be observed, however, that there are other ways of bringing into play the dormant energies of the land, besides deep and subsoil ploughing and trenching. Some plants have an extraordinary capacity and disposition to seek food at great depths in the soil—not vegetable food, for there is none in such situations, generally speaking, to be had, but mineral food;—for this they will send down their roots, in many cases, to many times the depth which the most enthusiastic advocate of subsoiling would hope to attain—and in their subsequent growth at the expense of so distant a source of nourishment they effect a far more important chemical addition to the surface soil than the subsoil plough could accomplish.

The perfection of a fallow crop, either root or otherwise (other circumstances of facility of cultivation, amount and feeding properties of the crop being equal), would be that which, whilst requiring for the completion of its own structure a considerable quantity of valuable mineral ingredients, should be possessed of an energy and power of obtaining them quite independent of any extraneous supply in the shape of artificial manures. In other words, a scientific review of the conditions of vegetable growth, apart from circumstances of practical detail, would indicate as the best fallow crop a plant with large spreading leaves, strong penetrating roots, and nutritive qualities in the feeding of stock, provided that at the same time its ash were in quantity and composition such as would benefit the cereals for which it is intended to prepare the food.

Of this latter point there would be little fear, supposing that the plant was really superior in feeding properties; for an examination of the evidence at present existing in reference to the ash of plants, amply demonstrates that those parts of plants (such as the seeds of the cereals) which owe their high nutritive powers to the large quantity of nitrogenized bodies (gluten, albumen, &c.) they contain, are also proportionably rich—invariably so—in phosphates of lime, magnesia, and potash.

This question then might be resolved by either of two methods of investigation. It might be decided practically—that is, it might be ascertained by observation and experiment in the field what

kind of crop grows most rapidly with least manure, furnishing the greatest quantity of most nutritive food. Or it might be decided by chemical analysis—in which case, however, the advantages to be derived from the culture of any particular plant, might be modified or entirely nullified by some practical difficulties not anticipated by its scientific examination.

Should however chemical investigation succeed in bringing into more favourable notice and general culture, any one plant of superior capabilities in the abovementioned respect, it will amply repay the attention which agriculturists are at the present time inclined to bestow upon it. We shall have at the conclusion of this report to compare the mineral composition of the most important root crops; and although we do not hope to show any very distinct reasons why one of these should be preferred as a fallow crop to others in use, we can only clearly state their relative value in the preparation of mineral food for the cereals, leaving the practical man to draw upon his own knowledge of the habitudes of the plants for the practical application of the information afforded by their chemical analysis.

Let it not be thought from the foregoing remarks, that we can take only one narrow contracted view of the relation which the culture of the root crop bears to the whole rotation, or that we seek to explain the advantages of existing practices and modern improvements, *solely* upon chemical principles. A practical farmer will tell us, that there are twenty ways in which the root crops are beneficial to his land. That they are means in his hands for altering the texture of the soil; that they afford him opportunity of cleansing and well stirring it, &c. This is very true; but after all, it will be found that their most important function is (as before said) the collection and preparation of food for the cereals. The root crops may be called the nurses of the tender and helpless corn plants; like nurses, they themselves require food, but their organs are of a nature to render them less dependent upon the character of that food. Food is, indeed, the first consideration to plants as well as animals; give a man plenty of wholesome nutritious food, and he will be comparatively safe from the attacks of disease, and indifferent to the inclemency of the weather. Stint him in his supplies of this first necessary, and you leave him an easy prey to both. Is it otherwise with plants? Surely not—they too must be fed; if nature does not supply them liberally enough, the care of man must make good the deficiency; but until he knows *what* they require his efforts can hardly fail of being in many cases abortive, or, where successful, attended with unnecessary waste.

And here we come to the point from which we started; the

cereals require two kinds of manuring, mineral and vegetable—the roots require *principally* only one, the first of these.* Supply your roots with mineral nourishment, and whilst by the increase of their produce you are enabled (so to speak) to grow a larger quantity of mutton and beef, and milk, you will ensure also a more abundant return of the more valuable crops, for which the turnip and mangold eventually become the mineral as well as vegetable sustenance.

Now what is the mineral food which the different root crops require?

This is the question which we hope in some degree to answer in the following pages; and we trust that the obvious importance of the subject will be our excuse for entering into considerable detail for its elucidation.

The crops which form the subject of our present report were, as in the former case, collected from different localities; they are in most instances the produce of ordinary culture. It has appeared to us best at the outset to examine—not peculiar or anomalous specimens, but those of ordinary average growth. As in our last report, so in the present, we have given the histories of a great many samples, that could not for want of time be subjected to complete analysis. Of their mineral matter the quantity is determined, but its composition is unknown—it is right that they should remain on record in the Society's publications, and they are given with all the information which could be collected concerning them. Our obligations to gentlemen who have supplied us with specimens for analysis, are here thankfully acknowledged. We are indebted in this particular to Sir J. Johnstone, Bart.; the Rev. A. Huxtable; Mr. Arkell, of the Agricultural College of Cirencester; Mr. Thomas Browne, of Cirencester; Mr. Morton, of Whitfield; Mr. Guppy, of Bradninch, Devon; and Mr. Wickham, of Batcombe, near Shepton Mallet, Somersetshire.

We have again to acknowledge with pleasure the invaluable assistance received from Mr. Henry Tanner, of Exeter, in the general prosecution of the research.

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* It is never intended by this to assert that the root-crops can be raised without *any* organic food in the soil; but there is great reason to believe that, with a small supply of "stimulating" organic nourishment (as guano), to enable them to *form their leaves*, the turnip or the mangold may be raised without further *vegetable* supplies from the soil.

TURNIPS.

Specimen No. 76.—Laing's Self-preserver Swede.

From Mr. Arkell.

[*Soil*, brashy; *subsoil*, stone; *geological formation*, the forest marble; undrained. After wheat. Manured for the Swedes with 3 cwt. of Peruvian guano, 1 cwt. of superphosphate of lime, and 20 bushels of ashes. Drilled on the flat at 21 inches, June 17, 1846. Appearance of the crop fair. Collected in November.]

Estimated produce in bulbs, 12 tons.
,, ,, in tops, 1 ton 16 cwt.*

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	87·7	·79	6·40
Tops	86·0	1·88	13·40

Mineral matter on an acre:—

Bulbs	211 lbs.
Tops	76
	287

Specimen No. 77.—Skirving's Swede.

From Mr. Guppy, Bradninch, Devon.†

[*Soil*, a rich loam of moderate consistence; *subsoil*, a compact mixture of clay and sand to a great depth, *un*drained but naturally dry. Previous crop, 30 bushels of wheat; turnips manured with a compost of 15 cart-loads of farm-yard manure and 10 loads of highway soil, and with 25 bushels of lime, and about 8 bushels of a mixture of soot, night-soil, and wood-ashes, drilled with the seed. Planted June 30, 1846. Collected Nov. 26.

Produce in bulbs, about 28 tons.
,, in tops, 3 tons 2 cwt.

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	87·9	·88	7·30
Tops	85·8	1·61	11·30

Mineral matter on an acre:—

Bulbs	550 lbs.
Tops	76
	626‡

* For some remarks on the estimation of the proportion of bulb to top, see p. 168.
† Grown by Mr. Alexander Read, of Werth Farm, Silverton.
‡ From this amount we have to deduct the carbonic acid, which (whatever may be

Analysis of the ash of the bulb:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·63	9·0 lbs.*
Phosphoric Acid	12·51	68·8
Sulphuric Acid	11·26	61·9
Carbonic Acid	9·54	52·5
Lime	11·36	62·4
Magnesia	2·44	13·4
Peroxide of Iron	0·28	1·5
Potash	36·16	198·8
Soda	4·99	27·4
Chloride of Sodium	9·77	53·7
Chloride of Potassium	none.	none.
Total	99·94	519·4†

Analysis of the ash of the top:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	4·11	3·1 lbs.
Phosphoric Acid	6·51	5·0
Sulphuric Acid	6·50	4·9
Carbonic Acid	6·16	4·7
Lime	23·99	18·2
Magnesia	2·92	2·2
Peroxide of Iron	1·90	1·4
Potash	20·36	15·5
Soda	none.	none.
Chloride of Sodium	17·69	13·4
Chloride of Potassium	9·77	7·4
Total	99·94	75·8

Specimen No. 78.—Skirving's Swede.

From Mr. Arkell.

[*Soil*, stone-brash; *subsoil*, ditto; *geological formation*, the great oolite. After wheat. Manured for turnips with 6½ cwt. of "animalized manure"‡ and 12 bushels of ashes (*no* farm-yard manure). Drilled on the flat at 21 inches, May 30th, 1846. Appearance of the crop middling: *thin* plant. Collected end of November.]

Produce in bulbs, 7 tons 15 cwt.
,, in tops, 11¾ cwt.

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its origin) is not to be looked upon as one of the *mineral* matters requisite to the well-being of the plant, although it is necessary to take account of its existence in the ash.

In the present case the carbonic acid in both bulb and leaf amounts to 57·2 lbs. on the whole crop of an acre. In other instances, where the *quantity* only of the ash is known, a deduction of about 12·0 per cent. on the bulb ash, and 10·0 per cent. on the ash of the top, may be safely assumed as *near* the proper proportion.

* We have thought it better to give these quantities in lbs. and *tenths* of pounds, rather than in pounds and ounces, as in the last report.

† These numbers are not *absolutely* the same as those before given—the proportion being only worked out to the nearest tenth.

‡ Preparations sold under these names, but of which we do not know the composition.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	87·0	0·60	4·60
Tops	86·0	2·35	16·80

Mineral matter on an acre :—

Bulbs	104 lbs.
Tops	24
	128

SPECIMEN NO. 79.—SKIRVING'S SWEDE.

From Mr. Arkell.

[*Soil* and *subsoil* same as Specimen 78 (being a portion of the same field). After wheat. Turnips manured with ½ cwt. superphosphate of lime, 3 cwt. guano, and 16 bushels of ashes. Drilled on the flat at 21 inches June 17, 1846. Appearance of the crop fair. Collected end of November.]

Estimated produce, bulbs, 12 tons.
" " tops, 15½ cwt.

Per-centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	88·0	0·81	6·72
Tops	84·0	2·64	16·5

Mineral matter on an acre :—

Bulbs	216 lbs.
Tops	46
	262

SPECIMEN NO. 80.—SKIRVING'S SWEDE.

From Mr. Arkell.

[Soil, subsoil, previous crop, &c., same as Specimen Nos. 78 and 79. Manured for turnips with 7½ cwt. "chemically prepared night-soil"* and 12 bushels of ashes. Drilled on flat at 21 inches, May 30, 1846. Crop looked middling but thin. Collected latter end of November.]

Produce in bulbs, 10 tons 9 cwt.
" in tops, 13½ cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	87·0	0·52	4·0
Tops	84·0	1·76	11·0

* Preparations sold under these names, but of which we do not know the composition.

Mineral matter on an acre :—

Bulbs	121 lbs.
Tops	27
	148

Specimen No. 81.—Skirving's Swede.

From Mr. Arkell.

[Soil, subsoil, &c. same as three preceding specimens; turnips entirely unmanured. Drilled on the flat at 21 inches, May 30th. Crop looked middling but thin.]

Produce in bulbs, 8 tons 15 cwt.
,, in tops, 15 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	86·0	0·71	5·11
Tops . . .	82·0	1·44	8·00

Mineral matter on an acre :—

Bulbs	141 lbs.
Tops	24
	165

Specimen No. 82.—Skirving's Swede.

From the Rev. A. Huxtable.

[*Soil*, composed of the detritus of flint and chalk; *subsoil*, hard chalk; does not need draining. Previous crop, wheat 40 bushels an acre. (*Mildewed. See* last report, page 624.) Manured with fermented (almost spent) farm-yard manure, 20 single-horse cart-loads per acre, and the seed drilled in 1 cwt. of bones and ½ cwt. sulphuric acid, with 20 bushels of ashes per acre. Excellent crop, but very much mildewed in growth.]

Estimated produce, bulbs, 20 tons.
,, ,, tops, 2 tons 9 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	87·5	0·75	6·00
Tops	88·0	1·97	16·40

Mineral matter on an acre :—

Bulbs	336 lbs.
Tops	108
	444

Analysis of the ash of the bulb :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	2·69	9·4
Phosphoric Acid	9·31	31·3
Sulphuric Acid	16·13	54·2
Carbonic Acid	10·74	36·2
Lime	11·82	39·7
Magnesia	3·28	11·0
Peroxide of Iron	0·47	1·6
Potash	23·70	79·6
Soda	14·75	49·6
Chloride of Sodium	7·05	23·7
Chloride of Potassium	none.	none.
Total	99·94	336·3

Analysis of the ash of the top :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	8·04	8·7
Phosphoric Acid	4·85	5·2
Sulphuric Acid	10·36	11·2
Carbonic Acid	6·18	6·6
Lime	28·49	30·8
Magnesia	2·62	2·8
Peroxide of Iron	3·02	3·3
Potash	11·56	12·5
Soda	12·43	13·4
Chloride of Sodium	12·41	13·4
Chloride of Potassium	none.	none.
Total	99·96	107·9

Specimen No. 83.—Skirving's Swede.

From the Rev. A. Huxtable.

[*Soil*, dark mould; *subsoil*, yellow clay; *geological formation*, clay under lower chalk; drained; two years in tillage. After good crop of wheat; turnips manured with 10 bushels of soot, and 10 bushels of pure cowdung mixed with 20 bushels of ashes, and 1 cwt. of bones with 56 lbs. of sulphuric acid. Drilled early in May. Crop dreadfully mildewed, and when collected (in November), three-fourths of the Swedes *rotten.*]

Produce in bulbs, 16 tons.
„ in tops, 2 tons 12 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	89.0	0·76	6·90
Tops	85·0	1·95	13·00

Mineral matter on an acre :—

Bulbs	271 lbs.
Tops	114
	385

Analysis of the ash of the bulb.—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·73	4·7
Phosphoric Acid	10·17	27·5
Sulphuric Acid	15·53	42·1
Carbonic Acid	11·96	32·4
Lime	14·33	38·9
Magnesia	3·27	8·9
Peroxide of Iron	0·61	1·6
Potash	26·88	72·8
Soda	13·31	36·1
Chloride of Sodium	2·19	5·9
Chloride of Potassium	none.	none.
Total	99·98	270·9

Analysis of the ash of the top:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·14	1·3
Phosphoric Acid	6·21	7·1
Sulphuric Acid	12·20	13·9
Carbonic Acid	12 97	14·8
Lime	30·38	34·6
Magnesia	3·18	3·6
Peroxide of Iron	0·66	0·7
Potash	20·79	23·7
Soda	none.	none.
Chloride of Sodium	10·31	11·8
Chloride of Potassium	2·09	2·4
Total	99·93	113.9

Specimen No. 84.—Dale's Hybrid.

From the Rev. A. Huxtable.

[Soil, subsoil, geological formation, &c., same as Specimen No. 83. Crop in the previous year wheat; this is a stubble crop grown after early peas this year. Manured with unfermented cowdung and ashes, and 1 cwt. of bones and 56 lbs. of sulphuric acid per acre. Drilled early in August. Crop very thick, the roots nearly touching each other on all sides. Collected middle of November.]

Estimated produce in bulbs, 20 tons.
" " in tops,* 10 tons.

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	88·0	1·01	8 41
Tops	89·0	1·19	10·80

* This would seem a very large proportion of top to bulb, but the proportion, as ascertained by us, was as 67 bulb to 33 top. See page 168.

Mineral matter on an acre :—

Bulbs	452 lbs.
Tops	267
	719

Analysis of the ash of the bulb :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	2·75	12·4
Phosphoric Acid	8·77	39·6
Sulphuric Acid	11·71	53·0
Carbonic Acid	12·66	57·2
Lime	6·46	29·2
Magnesia	2·51	11·3
Peroxide of Iron	0·14	0·6
Potash	36·93	166·8
Soda	8·01	36·2
Chloride of Sodium	10·00	45·2
Chloride of Potassium	none.	none.
Total	99·94	451·5

Analysis of the ash of the top :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·26	3·4
Phosphoric Acid	4·58	12·2
Sulphuric Acid	6·71	17·9
Carbonic Acid	13·82	36·9
Lime	35·10	93·7
Magnesia	1·75	4·7
Peroxide of Iron	0·61	1·6
Potash	13·53	36·3
Soda	4·60	12·3
Chloride of Sodium	18·02	48·3
Chloride of Potassium	none.	none.
Total	99·98	267·3

Specimen No. 85.—Dale's Hybrid.

From the Rev. A. Huxtable.

[*Soil*, composed of flint and chalk; *subsoil*, hard chalk (soil, previous crop, manure, &c., identical with those of Specimen 82). Drilled early in August.]

Estimated produce, bulbs, 20 tons.
„ „ tops, 4 tons 8 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	92·0	0·73	9·06
Tops	86·0	2·25	16·10

Mineral matter on an acre :—

Bulbs	324 lbs.
Tops	222
	546

Analysis of the ash of the bulb :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·12	3·6
Phosphoric Acid	10·71	34·7
Sulphuric Acid	11·22	36·4
Carbonic Acid	12·05	39·1
Lime	8·87	28·7
Magnesia	1·93	6·2
Peroxide of Iron	0·63	2·0
Potash	32·39	105·2
Soda	6·71	21·1
Chloride of Sodium	14·30	46·6
Chloride of Potassium	none.	none.
	99·93	323·6

Analysis of the ash of the top :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	7·35	16·3
Phosphoric Acid	11·70	26·0
Sulphuric Acid	6·99	15·5
Carbonic Acid	6·10	13·5
Lime	24·27	53·8
Magnesia	3·57	7·9
Peroxide of Iron	3·09	6·9
Potash	12·35	27·4
Soda	none.	none.
Chloride of Sodium	22·70	50·4
Chloride of Potassium	1·84	4·1
Total	99·96	221·8

SPECIMEN No. 86.—GREEN-TOPPED WHITE TURNIP.

From the Rev. A. Huxtable.

[*Soil*, dark mould; *subsoil*, yellow clay; *geological formation*, clay under lower chalk; drained; two years in tillage. The crop in the previous year wheat, but this is a stubble crop grown after peas this year.* Manured with unfermented cowdung and ashes and 1 cwt. of bones, with ½ cwt. of sulphuric acid. Remarkably thick crop, the roots almost touching each other on all sides. Drilled in August. Collected middle of November.]

Estimated produce, bulbs, 20 tons.
" " top, 12 tons 5 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	92·0	0·59	7·40
Tops	88·0	1·82	15·20

Mineral matter on an acre :—

Bulbs	268 lbs.
Tops	500
	768

* The description applies equally to this specimen and specimen 84, but it is here repeated to save confusion.

Analysis of the ash of the bulb :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	0·96	2·6
Phosphoric Acid	7·65	20·5
Sulphuric Acid	12·86	34·5
Carbonic Acid	14·82	39·7
Lime	6·73	18·0
Magnesia	2·26	6·1
Peroxide of Iron	0·66	1 8
Potash	48·56	130·0
Soda	none.	none.
Chloride of Sodium	5·44	14·6
Chloride of Potassium	none.	none.
	99·94	267·9

Analysis of the ash of the top :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	2·05	10·2
Phosphoric Acid	3·15	15·7
Sulphuric Acid	7·83	39·2
Carbonic Acid	14·64	73·2
Lime	28·73	143·7
Magnesia	2·85	14·2
Peroxide of Iron	0·80	4 0
Potash	12·68	63·4
Soda	none.	none.
Chloride of Sodium	10·67	53·4
Chloride of Potassium	16·56	82·8
Total	99·96	499·8

Specimen No. 87.—White Globe Turnip.

*From Mr. Guppy.**

[*Soil*, sandy loam ; *subsoil*, gravel ; naturally dry ; old tillage. Previous crop 30 bushels of wheat ; turnips manured with 15 cart-loads of farm-yard manure, as compost. Drilled with a mixture of soot, night-soil, and ashes, July 20, 1846. Collected 27th of November, very luxuriant crop.]

Estimated produce, bulbs, 35 tons.
„ „ tops, 6 tons 14 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	87·0	1·13	8·70
Tops	87·0	2·34	18·00

Mineral matter on an acre :—

Bulbs	886 lbs.
Tops	351
	1237

* Grown by Mr. Read of Silverton.

Specimen No. 88.—White Swede.

From Mr. Arkell.

[*Soil*, clay; *subsoil*, clay and stone; *geological formation*, the forest marble; not drained. Previous crop wheat. Manured for the Swedes with 10 one-horse cartloads of tolerably rotten yard manure; 1¼ cwt. Fothergill's superphosphate and 18 bushels of ashes, drilled with the seed, June 27, 1846, at 21 inches on the flat. Crop looked fair. Collected in November.]

Estimated produce, in bulbs, 12 tons.
„ „ in tops, 1 ton 19 cwt.

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	87·0	0·94	7·20
Tops	84·0	1·49	9·3

Mineral matter on an acre:—

Bulbs	252 lbs.
Tops	65
	317

Specimen No. 89.—Green-topped Swede.

From Mr. Arkell.

[*Soil*, stone; *subsoil*, ditto; *geological formation*, forest marble; undrained. After wheat; manured for the turnips with 12 one-horse cart-loads of tolerably rotten yard-manure, and 1¼ cwt. Fothergill's superphosphate and 18 bushels of ashes drilled with the seed on ridges at 28 inches, June 26, 1846. Crop looked thin. Collected in November.]

Estimated produce, in bulbs, 10 tons.
„ „ in tops, 17½ cwt.

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	90·0	0·53	5·30
Tops	82·0	1·51	8·40

Mineral matter on an acre:—

Bulbs	119 lbs.
Tops	30
	149

Specimen No. 90.—Purple-top Swede.

From Mr. Arkell.

[Soil, subsoil, and manure same as Specimen No. 89. Drilled on ridges at 28 inches, June 25, 1846. Crop looked thin. Collected in November.]

Estimated produce, in bulbs, 12 tons.
" " in tops, 18 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	90·0 . .	0·56 . .	5·63
Tops . . .	79·0 . .	2·25 . .	10·5

Mineral matter on an acre :—

Bulbs	151 lbs.
Tops	45
	196

Specimen No. 91.—Green Round Turnip.

From Mr. Arkell.

[*Soil*, brashy; *subsoil*, stone; *geological formation*, great oolite; naturally dry. Previous crop rye, eaten with sheep; seed drilled with 1 cwt. of guano, 2 bushels of bones, and ½ cwt. of sulphuric acid and 18 bushels of ashes, on the 12th July, at 21 inches on the flat. Very fair looking crop.]

Estimated produce, in bulbs, 12 tons.
" " in tops, 1 ton 7 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	90·5 . .	0·68 . .	7·20
Tops . . .	86·0 . .	1·54 . .	11·00

Mineral matter on an acre :—

Bulbs	184 lbs.
Tops	47
	231

Specimen No. 92.—Purple-top Scotch Turnip.

From Mr. Arkell.

[*Soil*, brashy ; *subsoil*, stone ; *geological formation*, great oolite. After oats and vetches, fed with sheep ; 1 cwt. guano, 2 bushels of bones,

with ½ cwt. sulphuric acid and 18 bushels of ashes, drilled with the seed, July 10, 1846, at 21 inches on the flat. Collected in November. Crop looked very fair.]

Estimated produce, in bulbs, 13 tons.
„ in tops, 1 ton, 9 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	92·4 . .	0·61 . .	8·00
Tops . . .	85·2 . .	2·12 . .	14·3

Mineral matter on an acre :—

Bulbs	177 lbs.
Tops	69
	246

Specimen No. 93.—Green-top Scotch.

From Mr. Arkell.

[Soil, subsoil, manure, and entire culture the same as Specimen No. 92.

Estimated produce, in bulbs, 13 tons.
„ „ in tops, 1 ton 12 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	92·2 . .	0·70 . .	8·98
Tops . . .	88·0 . .	1·50 . .	12·50

Mineral matter on an acre :—

Bulbs	204 lbs.
Tops	54
	258

Specimen No. 94.—White Decanter Turnip.

From Mr. Arkell.

[*Soil*, brashy and thin; *subsoil*, stone; *geological formation*, great oolite. Previous crop "grass and couch" (the turf pared and burned). Drilled on the flat at 21 inches, June 24, 1846, with 1½ cwt. Fothergill's superphosphate. Appearance of the crop good, but the land foul. Collected in November.]

Produce in bulbs, 15 tons.
„ in tops, 3 tons.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	92·7 . .	0·48 . .	6·60
Tops . . .	84·6 . .	2·00 . .	13·00

Mineral matter on an acre:—

Bulbs	162 lbs.
Tops	134
	296

Specimen No. 95.—Green-top Scotch Turnip.

From Mr. Arkell.

[*Soil*, brash and clay; *subsoil*, stone and clay; *geological formation*, the "forest marble;" undrained. After wheat; manured for the turnips with 2 cwt. guano, 1½ cwt. superphosphate, and 17 bushels of ashes. Drilled on the flat at 21 inches' distance, July 9th, 1846. Crop looked well. Collected in November.]

Produce in bulbs, 13 tons.
,, in tops, 2 tons 12 cwt.

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	90·0	0·84	8·40
Tops	84·0	1·92	12·00

Mineral matter on an acre:—

Bulbs	245 lbs.
Tops	99
	344

Specimen No. 96.—Scotch Purple-top Bullocks Turnip.

From Sir J. Johnstone, Bart.

[*Soil*, free hazel loam; *subsoil*, gravel; *geological formation*, the Oxford clay, but here covered up with calcareous rubble from above; undrained. Previous crop wheat (heavy straw, much laid; very poor crop of grain). Turnips manured with 6 loads of good rotten farmyard dung, and about 3 cwt. guano and 20 bushels of ashes. Drilled middle of June; very even good crop for the district. Collected November 21st.]

Estimated produce, in bulbs, 15 tons.*
,, ,, in tops, 2 tons, 13 cwt.

* In this and the following specimens the numbers given for the crop must be considered only as an approximation. This crop of turnips, it is said, "would carry 200 hogs for a week per acre." In calculating the produce, it has been assumed that a hog will eat 24 lbs. of turnips per diem (see Stephens' 'Book of the Farm,' vol. ii. p. 18); but of course any such calculation must be attended with much uncertainty. We have, however, preferred giving these data rather than none at all, but it is not proposed to use them as the basis of any argument.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	92·0	0·65	8·12
Tops	87·0	1·93	14·80

Mineral matter of an acre :—

Bulbs	219 lbs.
Tops	115
	334

Specimen No. 97.—Purple-top Swedes.

*From Sir J. Johnstone, Bart.**

[*Soil*, a free gravelly loam; *subsoil*, partly clay and partly gravel; *geological formation*, one of the sandstone beds of the coal-grit series; undrained. Previous crop 4 quarters of wheat; manured for the swedes with 8 loads of good rotten farm-yard manure and 1½ load of ashes. Drilled on the level about the middle of May, 1846; good even crop. Collected November 21st.]

Estimated produce, in bulbs, 15 tons.†
" " in tops, 19 cwts.

Per centage of water and ash :—

	Water.	Ash.	Ash calculate on dry substance.
Bulbs	90·0	0·82	8·20
Tops	82·0	1·95	10·80

Mineral matter of an acre :—

Bulbs	276 lbs.
Tops	41
	317

Specimen No. 98.—Swedes (variety not known).

From Sir J. Johnstone, Bart.

[Soil, subsoil, &c., identical with Specimen No. 97. Manured with 11 loads farm-yard manure per acre, 1 cwt. of guano, and 1½ load of ashes. Drilled on ridges the first week in May, 1846; good even crop. Collected November 21st.]

Estimated produce, in bulbs, 15 tons.
" " in tops, 12½ cwt.

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* Grown by Mr. Thomas Needham, Borget Farm, Harwood-dale, North Riding of Yorkshire.

† It is highly probable that this crop is underrated by our method of calculation, as the land is said to be some of the best in the neighbourhood, and well adapted (it would seem) for the turnip culture.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	90·0	0·42	4·20
Tops	85·0	1·59	10·6

Mineral matter of an acre :—

Bulbs	141 lbs.
Tops	22
	163

Specimen No. 99.—White Stone Turnip.

From Sir J. Johnstone, Bart.

[*Soil*, gritty limestone ; *subsoil*, limestone rubble ; *geological formation*, a limestone of the oolite ; undrained. Previous crop 3 quarters of barley (the *barley* was manured with 5 loads farm-yard dung per acre) ; turnips manured with 3 cwt. of guano and 20 bushels of ashes. Drilled middle of June ; a fair even crop. Collected November 23rd, 1846.]

Estimated produce, in bulbs, 11 tons.
" " in tops, 2 tons 8 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	92·0	0·80	10·03
Tops	90·0	1·42	14·20

Mineral matter of an acre :—

Bulbs	197 lbs.
Tops	76
	273

Specimen No. 100.—Scotch Purple-top Bullocks.

From Sir J. Johnstone, Bart.

[*Soil*, free, light, sandy ; *subsoil*, a red shale ; *geological formation*, the "Kelloways rock ;" undrained. Previous crop wheat (not worth reaping, being choked with rubbish) ; turnips manured with 6 loads farm-yard dung, 4 bushels of bones dissolved by sulphuric acid, and 20 bushels of ashes per acre. Drilled middle of June ; very fair even crop. Collected November 23rd.

Estimated produce, in bulbs, 13 tons.
" " in tops, 1 ton 12 cwt.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	92·0	0·87	10·90
Tops	87·0	2·08	16·00

Mineral matter of an acre:—

Bulbs	254 lbs.
Tops	74
	328

Specimen No. 101.—Scotch Purple-top Bullocks.

From Sir J. Johnstone, Bart.

[Soil, subsoil, &c., same as Specimen No. 100 (being part of the same field). 6 loads of farm-yard manure, 3 cwt. of guano, and 20 bushels of ashes. Drilled middle of June, 1846; good even crop (rather superior to Specimen No. 100). Collected 23rd November.]

Estimated produce, in bulbs, 13 tons.
„ „ in tops, 2 tons 10 cwt.

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	89·0 . .	1·10 . .	10·00
Tops . . .	90·0 . .	1·27 . .	12·70

Mineral matter on an acre:—

Bulbs	320 lbs.
Tops	71
	391

Specimen No. 102.—Yellow Bullocks.

*From Sir J. Johnstone, Bart.**

[*Soil*, free, variable; *subsoil*, strong clay; *geological formation*, a member of the coal-grit series; drained. Previous crop oats, 5 quarters per acre; manured for turnips with 10 cart-loads of farm-yard manure per acre, and 1 cart-load of turf-ashes. Drilled June 23rd, 1846; not even, but an average crop. Collected Nov. 21st.†]

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	89·0 . .	0·78 . .	7·10
Tops . . .	86·0 . .	1·58 . .	11·30

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* From the farm of Mr. Thomas Leadlay, Surgate Brows, Harwood-dale, North Riding of Yorkshire.

† We have no information respecting the amount of crop in this and the three following specimens: their history is, with this exception, complete, and is therefore given above.

Specimen No. 103.—Green-top Turnip.

*From Sir J. Johnstone, Bart.**

[*Soil*, free sandy loam; *subsoil*, sand and clay; *geological formation*, a member of the coal-grit series; undrained. After oats; turnips manured with 6 loads farm-yard dung, and 8 bushels of bones, with 1½ load of ashes. Drilled first week in July; pretty even crop, thin in places. Collected November 21st, 1846.]

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	91·0 . .	0·69 . .	7·70
Tops . . .	88·0 . .	1·44 . .	12·00

Specimen No. 104.—Eye-bright Turnip.

From Sir J. Johnstone, Bart.†

[*Soil*, "clum," (?) "difficult to reduce to a fine tilth for turnips;" *subsoil*, strong and stony; *geological formation*, coraline limestone (oolitic); undrained. After very poor crop of wheat run to straw (the seeds broken up for the wheat were well manured); manured for the turnips with 3 sacks of bones and 1 cart-load ashes per acre. Drilled June 19th, 1846; looked well. Collected November 23rd.]

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	91·0 . .	0·70 . .	7·80
Tops . . .	81·0 . .	2·58 . .	13·60

Specimen No. 105.—White Stone Turnips.

From Sir J. Johnstone, Bart.

[Soil, subsoil, &c., same as Specimen 104. After oats, six quarters per acre; much straw. Manured for the turnips with six loads farm-yard manure, 2½ cwt. of guano and 1 cart-load of ashes. Drilled May 28th, 1846; did not start well on account of the drought, but when collected a middling crop. Collected Nov. 23rd.]

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs . . .	91·0 . .	0·64 . .	7·10
Tops . . .	87·0 . .	1·94 . .	14·90

* Grown by Mr. W. Parker, Harwood-dale, North Riding of Yorkshire.

† Grown on the farm of Mr. John Cockerill at Hackness.

MANGOLD-WURZEL.

SPECIMEN NO. 106.—YELLOW GLOBE MANGOLD-WURZEL.

From the Rev. A. Huxtable.

[*Soil*, six inches of reddish mould, containing some clay; *subsoil*, chalk; *geological formation*, the upper chalk; does not need draining; 3 years in tillage. Previous crop 20 tons of Swedes; land manured for the mangold with ten bushels of *pure* dung of fatting beasts *unfermented*, mixed with 1 cwt. of bones, and ½ cwt. sulphuric acid (these, of course, separately mixed previously), and 10 bushels of ashes. *Dibbled* early in May (the manure being also dibbled); the tops blighted a good deal, and half the crown of the roots blackened with the blight. Collected in November.]

Produce, in roots, 22 tons.
„ in tops, 3 tons 17 cwt.*

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Roots . . .	91·0	1·02	11·32
Tops . . .	90·0	1·40	14·00

Mineral matter on an acre:—

Bulbs	502 lbs.
Tops	121
	623

Analysis of the ash of the bulb:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	2·22	11·1
Phosphoric Acid	4·49	22·5
Sulphuric Acid	3·68	18·5
Carbonic Acid	18·14	91·0
Lime	1·78	8·9
Magnesia	1·75	8·8
Peroxide of Iron	0·74	3·7
Potash	23·54	118·2
Soda	19·08	95·7
Chloride of Sodium	24·54	123·3
Chloride of Potassium . . .	none.	none.
Total	99·96	501·7

* The produce in tops, according to Mr. Huxtable, is five tons, instead of that mentioned in the text. In all likelihood Mr. Huxtable's is the more correct number, but having given in the other instances (where we had no *practical* estimate of the quantity of top) the relation as actually found in the specimen forwarded to us, we have thought it better, for the sake of uniformity, to abide by the same method in the present case.

Analysis of the ash of the top :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	2·35	2·9
Phosphoric Acid	5·89	7·1
Sulphuric Acid	6·54	7·9
Carbonic Acid	6·92	8·4
Lime	8·72	10·5
Magnesia	9·84	11·9
Peroxide of Iron	1·46	1·8
Potash	8·34	10·1
Soda	12·21	14·8
Chloride of Sodium	37·66	45·5
Chloride of Potassium	none.	none.
Total	99·95	120·9

Specimen No. 107.—Long Red Mangold-Wurzel.

From the Rev A. Huxtable.

[Soil, subsoil, and previous culture same as in Specimen No. 106, being part of the same field. Manured for the mangold with unfermented manure (*without straw*) of animals fed on linseed and corn mixed, with 1 cwt. of bones dissolved in ½ cwt. of sulphuric acid per acre, and worked up with ashes. *Dibbled* (both seed and manure) early in May. Collected in November.]

Produce, in roots, 24 tons.
„ in tops, 3 tons 15 cwt.*

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Roots	91·0	0·64	7·10
Tops	90·0	1·79	17·9

Mineral matter on an acre :—

Roots	343 lbs.
Tops	150
	493

Analysis of the ash of the root:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·40	4·8
Phosphoric Acid	1·65	5·7
Sulphuric Acid	3·14	10·7
Carbonic Acid	15·23	52·3
Lime	1·90	6·5
Magnesia	1·79	6·1
Peroxide of Iron	0·52	1·8
Potash	21·68	74·3
Soda	3·13	10·7
Chloride of Sodium	49·51	169·8
Chloride of Potassium	none.	none.
Total	99·95	342·7

* "Five tons"—Mr. Huxtable.

Analysis of the ash of the top :—

	n 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	2·26	3·4
Phosphoric Acid	5·19	7·8
Sulphuric Acid	4·60	6·9
Carbonic Acid	6·45	9·7
Lime	8·17	12·3
Magnesia	7·03	10·5
Peroxide of Iron	0·96	1·4
Potash	27·90	41·9
Soda	3·01	4·5
Chloride of Sodium	34·39	51·6
Chloride of Potassium	none.	none.
	99·96	150·0

Specimen No. 108.—Long Red Mangold-Wurzel.

From the Rev. A. Huxtable.

[*Soil*, dark mould; *subsoil*, yellow clay; *geological formation*, clay under the lower chalk; drained; two years in tillage. After good crop of wheat; manured for the mangold with unfermented dung (without straw) worked up with ashes, and 1 cwt. of bones in ½ cwt. sulphuric acid. Sown first week in May; very fine crop. Collected in November.]

Produce, in roots, 22 tons.
„ in tops, 5 tons 10 cwt.*

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Roots	90·0	1·00	10·00
Tops	90·1	1·91	19·10

Mineral matter of an acre :—

Roots	493 lbs.
Tops	235
	728

Analysis of the ash of the root :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	4·11	20·2
Phosphoric Acid	3·11	15·3
Sulphuric Acid	3·31	16·3
Carbonic Acid	21·61	106·5
Lime	2·17	10·7
Magnesia	2·79	13 8
Peroxide of Iron	0·56	2·8
Potash	29·05	143·3
Soda	19·05	93·9
Chloride of Sodium	14·18	69·9
Chloride of Potassium	none.	none.
Total	99·94	492·7

* About six tons—Mr. Huxtable.

Analysis of the ash of the top:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·38	3·2
Phosphoric Acid	4·39	10·3
Sulphuric Acid	6 26	14·7
Carbonic Acid	6·11	14·4
Lime	9·06	21·3
Magnesia	9·10	21·4
Peroxide of Iron	0·48	1·1
Potash	27·53	64·8
Soda	5·83	13·7
Chloride of Sodium	29·85	70·1
Chloride of Potassium	none.	none.
Total	99·96	235.0

Specimen No. 109.—Globe Mangold-Wurzel.

*From Mr. Guppy.**

[*Soil*, red and gravelly; *subsoil*, gravel to a great depth. Previous crop wheat, 27 bushels per acre; manured with 70 " seams " of half-rotten farm-yard manure per acre, mixed with earth as compost. Drilled first week in May; crop rather thin, but fine healthy plants; turnips sown to fill up. Collected early in November.]

Produce, in roots, rather more than 30 tons.†

(After the mangold was taken in there remained on the field half a crop of turnips.)

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Roots	86·0	0·92	6·60

Mineral matter of an acre:—

Roots . . . . 780 lbs.

Specimen No. 110.—Globe Mangold-Wurzel.

From Mr. Thos. Brown.

[Soil, subsoil, and geological formation same as Specimen No. 111. Previous crop 14 tons of swedes; manured for the mangold with coal-ashes and night-soil. Drilled April 11, 1846; crop looked well. Collected in November.]

Weighed produce, in bulbs, 36 tons 14 cwt.

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Roots	84·0	1·54	9·6

Mineral matter on an acre:—

Bulbs . . . . 1266 lbs.

* Grown by Mr. Thomas Dewdney, Silverton, Devon.

† The entire plant was not sent us. We have no information concerning the tops.

Specimen No. 111.—White Belgian Carrot.

From Mr. Thomas Brown.

[*Soil*, heavy red loam; *subsoil*, oolitic rubbly stones and white clay mixed; *geological formation*, the "Bradford clay;" drained; under spade-husbandry. Previous crop potatoes, 56 sacks (of 280 lbs. the sack) per acre; manured for the carrots with coal-ashes and night-soil. Drilled with the hoe April 13, 1846; plants looked well, but patchy; filled up with turnips. Collected in November.]

Weighed produce 22 tons in roots (besides the turnips).

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Roots	85·0	0·96	6·4

Mineral matter on an acre:—

Roots	473 lbs.

Specimen No. 112.—White Belgian Carrot.

From Mr. Arkell.

[*Soil*, stonebrash; *subsoil*, stone; *geological formation*, great oolite. After wheat; only manure for carrots 4 bushels of ashes per acre. Drilled at 12 inches in April; crop thin. Collected in November.]

Estimated produce, in roots, 7 tons.
" " in tops, 1 ton 18 cwt.

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Roots	85·0	0·77	5·12
Tops	75·0	5·32	21·30

Mineral matter on an acre:—

Roots	121 lbs.
Tops	226
	347

Analysis of the ash of the root:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	0·76	0·9
Phosphoric Acid	8·37	10·1
Sulphuric Acid	6·34	7·7
Carbonic Acid	15·15	18·3
Lime	9·76	11·8
Magnesia	3·78	4·6
Peroxide of Iron	0·74	0·9
Potash	37·55	45·4
Soda	12·63	15·3
Chloride of Sodium	4·91	5·9
Chloride of Potassium	none.	none.
Total	99·99	120·9

Analysis of the ash of the top:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	7·39	16·7
Phosphoric Acid	2·55	5·8
Sulphuric Acid	6·68	15·1
Carbonic Acid	16·29	36·8
Lime	34·98	79·0
Magnesia	2·50	5·6
Peroxide of Iron	4·06	9·2
Potash	7·28	16·4
Soda	9·46	21·4
Chloride of Sodium	8·77	19·8
Chloride of Potassium	none.	none.
Total	99·96	225·8

SPECIMEN No. 113.—WHITE BELGIAN CARROT.

From the Rev. A. Huxtable.

[*Soil*, dark mould; *subsoil*, yellow clay; *geological formation*, clay under lower chalk; drained; two years in tillage. After good crop of wheat; manured for the carrots with 8 bushels soot, and bones and sulphuric acid about 1 cwt., ½ cwt. guano, and 20 bushels of ashes per acre. Drilled (by hand) first week in May, 1846; splendid crop. Collected middle of November.]

Produce, in roots, 27 tons.
„ in tops, 6 tons 7 cwt.*

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance
Roots	87·0	0·82	6·30
Tops	76·0	4·20	17·50

Mineral matter on an acre:—

Roots	497 lbs.
Tops	597
	1094

Analysis of the ash of the root:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·10	5·5
Phosphoric Acid	7·86	39·0
Sulphuric Acid	6·95	34·5
Carbonic Acid	17·72	88·1
Lime	8·26	41·0
Magnesia	3·20	15·9
Peroxide of Iron	1·66	8·3
Potash	28·00	139·2
Soda	17·53	87·2
Chloride of Sodium	7·65	38·0
Chloride of Potassium	none.	none.
Total	99·93	496·7

* About six tons—Mr. Huxtable.

Analysis of the ash of the top:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·83	10·9
Phosphoric Acid	1·12	6·7
Sulphuric Acid	5·47	32·7
Carbonic Acid	22·75	135·9
Lime	29·50	176·3
Magnesia	3·03	18·1
Peroxide of Iron	0·90	5·4
Potash	7·53	44·9
Soda	10·69	64·4
Chloride of Sodium	17·14	102·4
Chloride of Potassium	none.	none.
	99·96	597·7

Specimen No. 114.—White Belgian Carrot.

From the Rev. A. Huxtable.

[*Soil*, six inches of reddish mould, containing some clay; *subsoil*, chalk; does not require draining; 3 years in tillage. Previous crop 20 tons of swedes; manured for the carrots with 1 cwt. of bones and ½ cwt. sulphuric acid, 1 cwt. guano and 20 bushels of ashes. Drilled end of April, 1846; very good crop. Collected middle of November.]

Produce, in roots, 16 tons.]
,, in tops, 3 tons 15 cwt.*

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Roots	85·0	0·92	6·10
Tops	82·0	2·85	15·80

Mineral matter on an acre:—

Roots	330 lbs.
Tops	236
	566

Analysis of the ash of the root:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·92	6·3
Phosphoric Acid	9·17	30·2
Sulphuric Acid	9·49	31·3
Carbonic Acid	19·11	63·0
Lime	11·89	39·2
Magnesia	5·89	19·4
Peroxide of Iron	1·37	4·5
Potash	21·40	70·6
Soda	14·21	47·0
Chloride of Sodium	5·52	18·2
Chloride of Potassium	none.	none.
	99·97	329·7

* Four tons—Mr. Huxtable.

Analysis of the ash of the top :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	4·48	10·6
Phosphoric Acid	1·34	3·2
Sulphuric Acid	5·86	13·8
Carbonic Acid	14·92	35·3
Lime	33·44	78·9
Magnesia	3·23	7·6
Peroxide of Iron	2·26	5·3
Potash	6·55	15·5
Soda	12·76	30·1
Chloride of Sodium	15·11	35·7
Chloride of Potassium	none.	none.
	99·95	236·0

Specimen No. 115.—White Belgian Carrot.

From Mr. Morton.

[*Soil*, deep sand; *subsoil*, rock (at some depth); *geological formation*, old red sandstone; naturally dry; 6 years in tillage. Previous crop 30 bushels of wheat; no manure whatever for the carrots. Drilled in rows 1 foot apart, second week in April, 1846; patchy crop (owing to hares). Collected first and second weeks of December.]

Estimated produce, in roots, 15 tons.
,, ,, in tops, 2 or 3 tons.*

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Roots	88·0	1·06	8·8

Analysis of the ash of the root :—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·16	4·1
Phosphoric Acid	8·09	28·9
Sulphuric Acid	5·37	19·2
Carbonic Acid	17·69	63·2
Lime	6·08	21·7
Magnesia	3·44	12·3
Peroxide of Iron	1·17	4·2
Potash	41·97	149·7
Soda	8·18	29·2
Chloride of Sodium	6·82	24·3
Chloride of Potassium	none.	none.
	99·97	356·8

* We were late in our application to Mr. Morton for specimens of roots, and the above had lost their leaves before we received them.

Specimen No. 116.—White Belgian Carrot.

From Mr. Morton.

[*Soil*, clay loam; *subsoil*, clay; *geological formation*, the upper silurian; drained; 6 years in tillage. Previous crop 40 bushels of wheat; no manure for the carrots. Drilled first week in April, 1846, in alternate rows with beans; the beans were harvested in August, and their place was then cultivated, much to the advantage of the carrots; fair crop, but much eaten by hares. Collected last week of November.]

Estimated produce, in roots, 10 tons.

(It must be remembered that this is really only *half* a crop; so that were it fair to calculate at the same rate, the produce on the acre would be 20 tons.)

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Roots	86·0	0·95	6·8

Analysis of the ash of the root:—

	In 100 parts.	Mineral matter removed in an Acre of Crop.
Silica	1·00	2·1
Phosphoric Acid	9·27	19·7
Sulphuric Acid	4·59	9·8
Carbonic Acid	16·86	35·9
Lime	8·17	17·4
Magnesia	3·48	7·4
Peroxide of Iron	0·59	1·3
Potash	33·29	70·7
Soda	15·06	32·1
Chloride of Sodium	7·62	16·2
Chloride of Potassium	none.	none.
	99·93	212·6

Specimen No. 117.—Jerusalem Artichoke.

From Mr. Wickham.

[Grown on a light calcareous soil; the manure, the amount of crop, &c., is not known.* The crop was luxuriant, the stems attaining a height of 10 or 12 feet.]

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Tubers	84·0	1·79	11 20
Stems	56·0	1·94	4·40
Leaves	47·0	15·00	28·30

* From a combination of circumstances, application was not made to Mr. Wickham for these particulars until it was too late to obtain them.

Analysis of the ash:—

	Bulb.	Stem.	Leaves.
Silica	1·52	1·51	17·25
Phosphoric Acid	16·99	2·97	0·61
Sulphuric Acid	3·77	3·23	2·21
Carbonic Acid	11·80	25·40	24·31
Lime	3·34	20·31	40·15
Magnesia	1·30	1·91	1·95
Peroxide of Iron	0·45	0·88	1·14
Potash	55·89	38·40	6·81
Soda	none.	0·69	3·72
Chloride of Sodium	none.	4·68	1·82
Chloride of Potassium	4·88	none.	none.
	99·94	99·98	99·97

Specimen No. 118.—White Peas.

From the Rev. A. Huxtable.

[*Soil,* chalk on the upper chalk; grown without manure (the peas were an early boiling variety: the amount of crop is not known).]

The proportion of grain to straw, including pods, in this crop was found, in two estimations on large quantities:—

First estimation	1000	grain to	1240·9	straw
Second Estimation	1000	,,	1135·0	,,
Mean	1000	,,	1187·9	,,

Per centage of water and ash:—

	Water.	Ash.	Ash calculated on dry substance.
Peas	17·50	1·97	2·39
Straw*	15·64	7·52	8·92

Analysis of the ash:—

	Peas.	Pea Straw.
Silica	1·76	2·53
Phosphoric Acid	24·20	1·31
Sulphuric Acid	4·70	1·85
Carbonic Acid	3·18	30·33
Lime	6·97	46·92
Magnesia	6·66	8·36
Peroxide of Iron	0·25	1·14
Potash	44·02	3·87
Soda	none.	1·86
Chloride of Sodium	8·23	1·76
Chloride of Potassium	none.	none.
	99·97	99·93

Specimen No. 119.—White Peas.

From the Rev. A. Huxtable.

[*Soil,* clay loam; *subsoil,* blue clay; well drained; sown without manure.]

* With the pods.

Relation of grain to straw as 1000 grain to 1333 straw.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Peas	16·00	2·25	2·68
Straw	15·38	7·96	9·40

Analysis of the ash :—

	Pe	Pea Straw.
Silica	0·84	1·94
Phosphoric Acid	28·85	1·23
Sulphuric Acid	5·85	2·26
Carbonic Acid	2·12	29·03
Lime	4·55	36·46
Magnesia	6·96	5·73
Peroxide of Iron	trace.	0·73
Potash	41·50	12·68
Soda	5·02	0·24
Chloride of Sodium	4·30	9·66
Chloride of Potassium	none.	none.
	99·99	99·96

SPECIMEN No. 120.—BEANS (variety unknown—COMMON FIELD BEAN).

From the Rev. A. Huxtable.

[*Soil*, clay loam, on blue clay; well drained; sown without manure.]

Proportion of beans to bean-straw (including the pods) as 1000 beans to 1012 straw.

Per centage of water and ash :—

	Water.	Ash.	Ash calculated on dry substance.
Beans	10·00	2·37	2·65
Bean Straw*	10·71	4·97	5·56

Analysis of the ash :—

	Beans.	Bean Straw (including pods†).
Silica	0·42	2·61
Phosphoric Acid	28·72	0·49
Sulphuric Acid	3·05	1·40
Carbonic Acid	3·42	25·32
Lime	5·20	19·85
Magnesia	6·90	2·53
Peroxide of Iron	trace.	0·61
Potash	51·72	32·85
Soda	0·54	2·77
Chloride of Sodium	trace.	11·54
Chloride of Potassium	none.	none.
	99·97	99·97

* Including the pods.

† The roots were cut off close, and not included in any of the estimations.

We will now endeavour to deduce some general principles from the analyses which have been detailed.

It should be clearly understood, however, that any views that may be advanced, cannot take from the reliance to be placed upon the analyses themselves. We may be right or wrong in the conclusions to which we are led by a review of the data before us; but be this as it may, the results obtained must be looked upon as matter of fact, and they are given in the fullest detail, so as to afford to every member of the Society the materials for forming his own judgment on the question. And first, let us examine the evidence concerning turnips.

In the last paper on wheat, we endeavoured to show that a consideration of the quantity of mineral matter removed by any crop, must necessarily include the relation in quantity existing between the different parts of the plant under examination. Were the ash of every portion of a plant the same in quantity and composition, a knowledge of the gross produce in any given case would suffice to indicate the amount of exhaustion produced. This is any thing but the actual state of things. The parts of plants differ in mineral composition fully as much as one entire plant does from another. To establish the relation between the grain and straw of a cereal was not a difficult matter, and reasons were given for believing that we had arrived at more accurate results than could be obtained on the large scale.

In separating the grain from the straw of 50 or 60 heads of wheat, there is every reason to believe that a correct average of the whole crop may be obtained; the number of individual plants being sufficient to destroy the effect of any one or two which might differ from the rest. But in the separation of the bulb of the turnip from the top, it is extremely difficult to say where the one begins and the other ends, and a very little deviation in this respect will undoubtedly influence the result of the estimation. It is probable that, to ensure the nearest approach to correctness, a very great number of turnips must be operated upon; but as such an estimation was not within our reach, we have adopted the best method under the circumstances, and trust that the numbers obtained may not be far from the truth.

The specimens of turnips were, as before mentioned, obtained from different localities, and many of them from great distances. They were always perfect specimens,* that is, the leaves were

* The accompanying printed directions which were forwarded to all parties who supplied us with crops, will at once show the precautions which were adopted to secure perfect specimens.

Should any member of the Society be desirous of aiding the present investigation, by contribution of specimens for analysis, a copy of the paper of questions which is employed by us to obtain information concerning

entire and healthy; they reached us with very little alteration, and were immediately preserved for analysis; the tops were separated

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any crop, will prove of assistance in pointing to the memoranda, which it is necessary to preserve. We have therefore subjoined it. A similar paper, with slight modifications, is made use of for other crops.

Directions for collecting Root Crops for Analysis.

The quantity of each Specimen should never be less than *six* or more than *ten* lbs., bulb and leaf taken together.
Do not collect the Specimens till quite ready to forward them, in order that they may arrive perfectly fresh.
Select healthy-looking plants.
If the crop is uniform all over the field, take medium-sized samples, *with all their leaves.*
If the bulbs are very irregular in size, take some small and others large, so as to give an average.
Brush off the loose dirt from the bulbs, but *do not wash them* nor remove the roots.
Draw the leaves together, and tie a piece of thick paper round them.
Tie upon each Specimen a piece of paper with a number and the name of the plant.
Put the corresponding number and the name on the accompanying paper of questions.
Pack the Specimens in a hamper or bag, and direct them to ———

Questions relating to Specimens supplied:—

Turnip, Swede, and Mangold-Wurzel Crops.

1. The name and variety of the crop.
2. The name of the party furnishing it, the farm, parish, and county.
3. The system of cultivation adopted on the farm.
4. The general character and value of the land on which sown.
5. The geological formation.
6. The nature of the soil.
7. The nature of the subsoil.
8. Whether drained or undrained.
9. What length of time in tillage or arable.
10. The previous crop and its yield.
11. If any farmyard manure, and how much.
12. In what state applied—as compost or from the yard
13. In what state of decomposition was the manure.
14. If any artificial manure:—
    Bones how much.
    Bones and sulphuric acid how much.
    Guano how much.
15. Any ashes, and how much.
16. Number of times ploughed, harrowed, &c.
17. The time of planting.
18. Whether drilled or sown broadcast.

19. The

from the bulbs at the extreme point of the latter, in such a way however that the base of the leaves was always sufficiently compact to hold them together when severed from the bulbs. At this particular point, the vegetable matter partakes of the character and consistency of both the bulb and the leaf; it may be thought by some that the separation should have taken place higher, by others lower in the plant; and there is no doubt that estimations by two different persons would not perfectly agree, with whatever care they might be effected. We claim for our results, however, the merit of uniformity. They are comparatively, if not absolutely correct. The quantity of turnip and turnip-top weighed, varied from 30,000 to 100,000 grs., and generally included three or four bulbs. In order that the extent of variation may be seen, a table is here given of all the turnips examined together, with the quantity of ash found in their bulbs and tops. The swedes and hybrids are included with the turnips (properly so called), because, as will be seen, there is little or no distinction between them, as far as mineral constitution is concerned. (See Table I., following page.)

It will be seen from this table, that the proportion of bulb to top is very variable; in one specimen (No. 86) being as 62 to 38 in 100 parts of the entire plant; in another instance (Spec. 98), as 96 to 4. These numbers represent, however, the extremes, so far as the specimens we have examined are concerned. Out of 30 specimens enumerated, 24 or 4-5ths range within the limits of 84 and 94 of bulb to 16 and 6 of top in the 100 parts. The mean of all the specimens is 86·8 of bulb to 13·2 of top; but if those which exhibit the greatest deviation are omitted (Specimens 84, 86, and 94), we shall obtain for the remaining 27 specimens a mean of 89 to 11.

These numbers would indicate a very much smaller proportion of top than is usually believed to obtain. As was before said, we do not wish more reliance to be placed upon the estimations than is their due; but there are good reasons for believing that they are not far wrong. Thus, 4 specimens of Skirving's swedes (78, 79, 80, 81), grown at the same time on the same

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19. The appearance of the crop.
20. The time at which it was collected.
21. The yield per acre perches being weighed $\begin{cases}\text{in roots.}\\ \text{in tops.}\end{cases}$

It is very desirable that precise information should be obtained with regard to the crops intended for analysis. With this object, it is wished that the questions above be answered as *fully* as possible. If, however, any difficulty should arise, or any question appear objectionable, the answer may be altogether omitted.

TABLE 1.—Relation of Bulb to Top, and per centage of Water and Ash in Turnips.

No. of Specimen.	Variety.	Relation of Bulb to Top in 100.		Bulb as 100.	Bulbs.			Tops.		
		Bulb.	Top.	Top.	Water.	Ash.	Ash calculated on dry substance.	Water.	Ash.	Ash calculated on dry substance.
76	Laing's Self-preserver	87	13	15·7	87·7	·79	6·40	86·0	1·88	13·40
77	Skirving's Swede. .	90	10	11·1	87·9	·88	7·30	85·8	1·61	11·30
78	Skirving's Swede. .	93	7	7·5	87·0	·60	4·60	86·0	2·35	16·80
79	Skirving's Swede. .	94	6	6·4	88·0	·81	6·72	84·0	2·64	16·50
80	Skirving's Swede. .	94	6	6·4	87·0	·52	4·00	84·0	1·76	11·00
81	Skirving's Swede. .	92	8	8·7	86·0	·72	5·12	82·0	1·44	8·00
82	Skirving's Swede. .	89	11	12·4	87·5	·75	6·00	88·0	1·97	16·40
83	Skirving's Swede. .	86	14	16·3	89·0	·76	6·90	85·0	1·95	13·00
84	Dale's Hybrid . .	67	33	49·3	88·0	1·01	8·41	89·0	1·19	10·80
85	Dale's Hybrid . .	82	18	22·0	92·0	·73	9·06	86·0	2·25	16·10
86	Green-top White . .	62	38	61·3	92·0	·59	7·40	88·0	1·82	15·20
87	White Globe turnip .	84	16	19·0	87·0	1·13	8·70	87·0	2·34	18·00
88	White Swede . . .	86	14	16·3	87·0	·94	7·20	84·0	1·49	9·30
89	Green-top Swede. .	92	8	8·7	90·0	·53	5·30	82·0	1·51	8·40
90	Purple-top Swede .	93	7	7·5	90·0	·56	5·60	79·0	2·25	10·50
91	Green Round turnip.	90	10	11·1	90·5	·68	7·20	86·0	1·54	11·00
92	Purple-top Scotch .	90	10	11·1	92·4	·61	8·00	85·2	2·12	14·30
93	Green-top Scotch. .	89	11	12·4	92·2	·70	8·98	88·0	1·50	12·50
94	Decanter Turnip. .	75	25	33·3	92·7	·48	6·60	84·6	2·00	13·00
95	Green-top Scotch. .	86	14	16·3	90·0	·84	8·40	84·0	1·92	12·00
96	Scotch Purple-top Bullocks . . .	85	15	17·6	92·0	·65	8·12	87·0	1·93	14·80
97	Purple-top . . .	94	6	6·4	90·0	·82	8·20	82·0	1·95	10·80
98	Swede	96	4	4·2	90·0	·42	4·20	85·0	1·59	10·60
99	White Stone turnip .	82	18	22·0	92·0	·80	10·03	90·0	1·42	14·20
00	Scotch Purple-top .	89	11	12·4	92·0	·87	10·90	87·0	2·08	16·00
01	Scotch Purple-top .	84	16	19·0	89·0	1·10	10·00	90·0	1·27	12·70
02	Yellow Bullocks .	86	14	16·3	89·0	·78	7·10	86·0	1·58	11·30
03	Green-top. . . .	87	13	15·0	91·0	·69	7·70	88·0	1·44	12·00
04	Eye-brights . . .	89	11	12·4	91·0	·70	7·80	81·0	2·58	13·60
05	White Stone . . .	93	7	7·5	91·0	·64	7·10	87·0	1·94	14·90

field, give very nearly a like proportion of bulb to leaf. The same thing occurs in Specimens 92 and 93, grown in the same field; and again, in Specimens 97 and 98, where the leaf in both is extremely small, but very similar in quantity. Another instance may be mentioned: Specimens 84 and 86 are Dale's hybrid and green-top white, autumn planted; they were drilled in August on pea stubble, and are remarkable for the large weight of their tops.

The similarity of proportion in these cases would lead to the inference that whatever errors may attend results obtained on so small a number of plants, the general relation of bulb to leaf is for many purposes sufficiently indicated by them. With the causes which conduce to the observed deviation we have little to do; these are no doubt various, the age of the plant, the period of planting, the particular culture and manures employed, and the peculiar habits of growth of different varieties (some of which exhibit a greater tendency to drop their leaves than others), each and all of these circumstances might operate in the production of a greater or less quantity of leaf; the influence of such causes, and the extent to which they may be made subservient to the will of the cultivator, can only be satisfactorily ascertained by comparative trials on the large scale. It may not, however, be out of place here to urge, upon scientific considerations, the importance in the root culture of securing a great breadth of leaf.

In the cultivation of the cereals it is rather a desideratum (and will become more so every day) to limit the production of straw, a part of the plant of *comparatively* little value, but at the same time very exhausting to the soil. In the turnip too, it would appear that the leaf is not so valuable as the root, both from the difficulty of preserving it from decay, and its tendency to produce purging in sheep and cattle.

But there is this difference between the two cases. The straw of the cereals requires a great quantity of vegetable matter for its formation, of which the greater part, if not all, comes from the soil. But the turnip, as we before said, is not dependent upon the soil for its organic food; and the increase of the leaves, instead of robbing the tubers, is a source of greater supplies towards their formation. The larger the leaves the greater, 'tis true, must be the amount of mineral matter required for these organs; but it will be seen presently, that even when the leaves are very large indeed, their demand for the rarer mineral constituents of the soil is not excessive; and were this even so, it would be better to insure a full supply of leaf at a small additional expense in artificial manure, than to forego the benefits to be derived from it in the increase of food for stock, and of organic matter in the soil for the succeeding crop.

Every means then it is thought should be made use of to produce an early and full development of the leaf of the root crops; and perhaps no more suitable period in the rotation could be selected by the farmer for the expenditure of the sum which he proposes to invest in artificial manures. This subject will, however, come before us more properly when we have considered the mineral composition of the turnip.

The next point of attention is the proportion of water in the bulbs and leaves of the turnip. It will be seen, by reference to the table, that the quantity of water in the bulbs varies between 86·0 (Spec. 81) and 92·7 (Spec. 94) per cent. These are the extremes; the mean of 30 specimens in the table will be found to be 90·0 per cent. This is rather above than below the number usually assigned to the water of the turnip bulb: but it is on that account the more trustworthy, for it is easier to err in drying these bodies too little than too much.* The water in the leaf has a greater range than in the bulb. The extremes are seen in Spec. 90 and 99, the first of which contains only 70, the second 90 per cent. The mean of all the specimens is 85·5. The large leaves appear to contain more water than the smaller ones. It may be thought that the latitude in the proportion of water in the leaves could be accounted for on the supposition that they had become partially and unequally dry before the estimation was commenced. This cannot have been the case, for—although it must not be denied that in the transit of the specimen from a great distance, some small amount of moisture may have passed off, especially from the leaves —it will be seen that the discrepancies occur equally amongst those which were similarly circumstanced in this respect, and that those specimens which were operated on directly they were removed from the soil (those from Mr. Arkell), exhibit an equal extent of difference in the per centage of water.

The varying quantity of water in turnips is only seen to be a matter of serious import when (as Professor Johnstone has properly observed) it is remembered that upon it very mainly depends the value of the particular specimen in the feeding of stock. It is true that the nutritive properties of any vegetable matter cannot be exactly estimated by the amount of dry weight which they represent; one vegetable containing a good deal of indigestible woody matter, another much easily soluble and digestible sugar and mucilage; whilst, at the same time, the flesh-forming nitrogenous principles may be in grèater or less abundance. But, in ignorance of any differences in this respect in the samples before us, we must estimate the value of each crop by the quantity of

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* For the method of estimating water, see p. 207. We may mention here that they were dried by a prolonged heat of 212° Fahr.

solid matter it contains; 10 per cent. (or 2 cwt. in every ton) the average amount of solid matter in the turnip bulb, but in the table an instance is seen where the solid matter is as low as 7·3, another in which it reaches 14·0—in other words, 10 tons of Specimen 81 contain very nearly as much solid nutritive matter as 20 tons of Spec. 94.

It is not easy to over-estimate the importance of this circumstance. If the table is examined it will be seen that the specimen alluded to (No. 81) as exhibiting the largest amount of solid matter in a given weight of bulb, has also (with two exceptions only) the least water in the top—in other words, as a whole this particular crop is weight for weight much more valuable than any other in the table. But if its history be asked for, it will be found that it was grown without manure, and was consequently not expected to be a good crop. For the sake of illustration let us compare this specimen with No. 79, grown on the same field, but in which, from the use of superphosphate of lime and guano, there is an increase of 3 tons 5 cwt. on the acre:—

Table 2.

Spec.	Water per Cent.		Produce.		Dry Weight in lbs.		
	Bulb.	Top.	Bulb.	Top.	Bulb.	Top.	Total.
			tons. cwt.	cwt.	lbs.	lbs.	lbs.
79	88·0	84·0	12 0	15½	3230	263	3493
81	86·0	82·0	8 5	15	2743	303	3046

It will be seen by this table that there is an increase in the dry weight by the use of artificial manure, but by no means to the same extent as in the wet produce:—

The apparent increase (that on the wet weight) is 35 per cent.
The real increase (that on the dry weight) is 14 per cent.

It were easy to draw comparisons between many of the crops in the table, which would show that the gross weight of the crop may but ill represent its value as compared with any other crop of greater or less produce. It is obvious then, however destructive it may be of the confidence to be placed in the experiments on record or the growth of turnips, that one vital circumstance has been usually omitted—*the dry weight of the crop.* A particular manure may raise 3 or 4 tons more turnips on an acre, but the greater crop may be even less valuable than the smaller produce, the excess of weight being more than counterbalanced by the greater proportion of water.

The same remarks will apply to the relative value of different crops in feeding sheep or cattle.

But this truth, unpalatable as it must be, should not discourage

such experimental trials, but rather force upon our attention the absolute necessity of conducting them in a scientific spirit. Nothing can be done effectually in the way of establishing agricultural statistics of this description unless attention be paid to every circumstance of the means employed and the result obtained.

We would not be thought to draw any other conclusion from these data than such as would convey a sense of the great caution necessary in all such experiments. That artificial manures may have a tendency in some cases to produce watery, ill-conditioned ("dropsical," as was said of the potato) plants is quite possible, and it is no less proved, both from our experiments and from the observations of practical men, that two crops may be widely dissimilar in their solid contents.

It is by no means an unusual thing for a farmer to remark, that a piece of turnips has carried so many head of sheep longer than from its appearance he would have expected. May not this be due to the circumstance which we have endeavoured to explain? Be it remembered that a given weight of turnips which would afford food to a flock of sheep for a fortnight, supposing that they contained 90 per cent. of water, would carry the same sheep 3 weeks if the quantity of water were only 85 per cent. That far greater differences than this really exist, the table before given fully proves, and, as we before said, this subject demands the most patient and rigorous examination. In all experiments on the growth of roots, it would be easy to make the corrections we have spoken of by selecting one or two healthy turnips from each lot, separating the tops, and after carefully removing the dirt by a brush and a little water, and slicing the bulbs, setting the whole to dry in a gentle oven or other moderate heat; they should be weighed at intervals of a week till they cease to lose weight. The original weight and that of the turnips when dry being known, we obtain the solid matter of the acre by an easy calculation.

This plan will afford the most certain data short of a chemical analysis of the constituents of each crop, by which alone we can ascertain whether the solid matter be always alike in character.

And now we come to consider the mineral matter in the turnip. One column of the table (page 173) affords us the information that 100 parts of turnip bulb, in its ordinary condition, may contain from ·48 to 1·13 parts of mineral matter. These are extreme cases. The mean per centage of the bulb-ash in all the specimens is ·73. There is here certainly a very considerable latitude in the quantity of mineral matter in different specimens of the same root, a latitude which is not accounted for by the variations in the proportions of water in the plants. This will at once be seen by inspection of the column in the table which gives the ash on the *dry* vegetable. The ash given by turnip-tops is in almost

all cases twice, in many three times as much as that of the bulbs; it varies between the limits of 1·19 (Spec. 84) and 2·64 (Spec. 79) per cent. The mean of all the specimens will be found to be 1·84 in 100 parts of wet leaf; the column which represents the ash on the dry tops contains numbers quite as different as those which are found for the tops in a wet state—that is, the ash is by no means the same in quantity in equal weights of the dry tops.

The following table gives at a view the mean proportion in water and ash in turnips and turnip-tops:—

TABLE 3.—Water, Ash, &c., in Turnips.

	Water.			Ash.			Ash, Dry.		
	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.
Bulb .	92.7	86·0	90·0	1·13	·48	·73	10·90	4·00	7·30
Top .	90·	79·0	85·5	2·64	1·19	1·84	18·00	8·00	12·98

The mean numbers are those of the 30 specimens in the former table; they need not necessarily be the mean of the high and low; but a little examination will show that they very nearly approach these quantities—in other words, the per centage of water and ash varies with tolerable uniformity both above and below the averages above given.

We have been unable to trace any connection between the amount of ash and the variety of the plant. The turnips, the swedes, and the intermediate variety, the hybrids, are in no way distinguished from each other by the quantity of mineral matter in them. The soil and manure have, no doubt, more to do with this: and yet in Spec. 82 and 83, one of them grown on chalk, the other on clay with such very different manures, we observe a very great similarity in the quantity of ash both in the bulb and the top, and in other cases a difference is seen in the mineral contents of two turnips of different varieties growing in the same field and same manure. But the evidence, on the whole, is in favour of the conclusion that the mineral matter is regulated *more* by the soil and manure than by the variety, although the distinctive character of the root is never set aside. We were prepared to find much greater diversity in the ash of the root crops than in that of the cereals (at all events of the grain); it may be presumed that in the perfect maturation of a seed, everything which is not required by the organization is ejected into the straw; the straw, therefore, would be less uniform than the grain, which latter would not be expected at any time to exhibit very striking mineral peculiarities. In the turnip, as in every succulent vegetable, it must be believed that there are two portions of mineral matter, one of which has

already been built up with the vegetable organization, and is therefore essential to the plant, the other portion present in the vegetable matter merely as it were accidentally—that is, the water entering a plant by its roots, necessarily carries into the circulation more or less of the soluble ingredients of the soil and manure, and at the time a plant is removed from the soil, its mineral food is about to be or has been selected from the mixed supplies so introduced. We have not at present, and it is very questionable whether we ever shall, the means of discriminating between the necessary and "accidental" ash of a plant,* and we can only therefore judge by comparison of one specimen with another how far the ash which may in any case be examined is to be looked upon as a mixture of the two.

Now the quantity of this accidental ash ought to be larger in those plants which contain much water; and accordingly we should, as before said, anticipate greater differences in respect to turnips than wheat. Indeed it may be taken as a most decisive proof, if such were wanted, of the intimate connection between the organic and inorganic parts of plants, that notwithstanding the large proportion of water, the difference of ash should be comparatively so slight.

A ton of turnip bulbs contains no less than 18 cwt., or 2016 lbs., of water. Now spring water, which has simply percolated the ordinary porous strata of the earth, contains usually about 3 grains of salts of lime, potash, &c., in every pound, and very frequently the proportion is found greatly to exceed this. 2016 lbs. of water, at 3 grains in the pound, would contain 6048 grains, or nearly 1 lb. of mineral matter: so that in a ton of turnips, which gives usually from 16 to 20 lbs. of ash (see p. 182), the water would retain in solution 1 lb. of the difference. But it is not to be supposed that the water passing in by the roots of a plant growing on a fertile and highly-manured soil is charged with salts to the same extent only as that which has passed through the hard and oft-washed beds of our sandstone and limestone strata; and it is easy to conceive that a great quantity of mineral matter may at any time be accidentally present in plants containing so much water as the turnip.

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* It might be possible to effect a separation of any soluble substances merely passing through the plant, by causing it to vegetate for a few hours in pure water after it is removed from the soil; there would, however, be danger in this plan from the abrasion of the roots. No washing of the plant for such a purpose would be admissible—for so soon as the organism of a vegetable is interfered with (by cutting it up or otherwise), there is no knowing what modifications of the essential mineral matter might occur.

There are other circumstances which must influence this result. The point of perfect maturity in a root crop cannot be defined so distinctly as that of a grain crop; and it may well be believed that as soon as a plant has reached this point, changes will occur to modify extremely the nature of the mineral matter. Some of these may be thrown back into the soil, and a difference of a week in the age of the plant may alter materially the results of the analysis. This question can only be fully enlightened by the examination of specimens periodically; every week or fortnight, that is, of their growth. We have long felt the necessity of this plan, which has been ably advocated by Professor Johnstone in the last edition of his valuable treatise; but we think it of more importance at present to limit our inquiry to the general rather than particular subjects which are connected with the inorganic constitution of vegetables. The composition of the ash of different specimens of turnips will be best seen if we give in a table the analyses before detailed:—

TABLE 4.—Composition (in 100 parts) of the Ash of Turnip Bulbs.

No. of Spec.	82	83	84	85	77	86	Mean of the six Specimens.
Variety.	Skirving's Swede.	Skirving's Swede.	Dale's Hybrid.	Dale's Hybrid.	Skirving's Swede.	Green-top White.	
Per Centage of Ash .	·75	·76	1·09	·725	·88	·592	..
Silica . .	2·69	1·73	2·75	1·12	1·63	·96	1·81
Phosph. Ac.	9·31	10·17	8·77	10·71	12·51	7·65	9·85
Sulph. Ac..	16·13	15·53	11·71	11·22	11·26	12·86	13·12
Carb. Ac. .	10·74	11·96	12·66	12·05	9·54	14·82	11·96
Lime . .	11·82	14·33	6·46	8·87	11·36	6·73	9·93
Magnesia .	3·28	3·27	2·51	1·93	2·44	2·26	2·61
Perox. Iron	·47	·61	·14	·63	·28	·66	·46
Potash . .	23·70	26·88	36·93	32·39	36·16	48·56	34·10
Soda . .	14·75	13·31	8·01	6·71	4·99	..	7·96
Chlo. Sodium	7·05	2·19	10·00	14·30	9·77	5·44	8·13
Chlo. Potass.	..	..	..	..	..	..	..
Total .	99·93	99·98	99·94	99·93	99·94	99·94	99·93

TABLE 5.—Composition (in 100 parts) of the Ash of Turnip Tops.

No. of Spec.	82	83	84	85	77	86	Mean of the six Specimens.
Variety.	Skirving's Swede.	Skirving's Swede.	Dale's Hybrid.	Dale's Hybrid.	Skirving's Swede.	Green-top White.	
Per Centage of Ash .	1·97	1·95	1·19	2·25	1·61	1·82	..
Silica . .	8·04	1·14	1·26	7·35	4·11	2·05	3·99
Phosph. Ac.	4·85	6·21	4·58	11·70	6·54	3·15	6·17
Sulph. Ac. .	10·36	12·20	6·71	6·99	6·50	7·83	8·43
Carb. Ac. .	6·18	12·97	13·82	6·10	6.16	14·64	9·98
Lime . .	28·49	30·38	35·10	24·27	23·99	28·73	28·49
Magnesia .	2·62	3·18	1·75	3·57	2·92	2·85	2·81
Perox. Iron	3·02	·66	·61	3·09	1·90	·80	1·68
Potash . .	11·56	20·79	13·53	12·35	20·36	12·68	15·21
Soda . .	12·43	..	4·60	..	..	..	2·84
Chlo. Sodium	12·41	10·31	18·02	22·70	17·69	10·67	15·30
Chlo. Potass.	..	2·09	..	1·84	9·77	16·56	5·04
Total .	99·96	99·93	99·98	99·96	99·94	99·96	99·94

From the first of these tables we may learn that there is a certain and somewhat close resemblance between the composition of the ash of one turnip-bulb and another. The quantity of phosphoric acid is seen to be tolerably constant, and the alkalies, together, make up very nearly the same amount. In our last report we remarked that there did not appear in the wheat crop which we had examined, any corroboration of the doctrine which supposes substitution of one alkali for another. The present analyses would favour the opposite conclusion, for the deficiency of potash in some specimens is to a certain extent made up by a greater quantity of soda.*

The second table exhibits far wider differences in the composition of the ash, the phosphoric acid of one (Specimen 85) being double that of some others, &c. &c. We were prepared for this. In the growth of plants of this description, the construction of the materials is supposed to go on in the leaves, from which the vege-

* To those who are unacquainted with the laws of chemical combinations, it may be necessary to remark, that soda and potash would not replace each other in *equal* quantities. The *saturating* power of each *base* is represented by a particular number, thus:—31 parts of soda (omitting fractions) will go as far as 47 of potash in any application as an alkali—in destroying the properties of an acid for instance. The same holds good in regard to plant-ashes. It is not therefore *absolutely* correct to compare the *united weight* of these bodies in one case with the same weight in another specimen.

table matter, when fully worked up, descends into the tuber, and is there deposited. The leaves would contain, therefore, not only their own proper mineral constituents, but the greater part of the excess of such bodies which had entered the plant.

The ash of the top differs from that of the bulb chiefly in containing less phosphoric and sulphuric acids, less potash, but a great deal more lime. Neither in the top or the bulb is there much silica, but the ash of both contains much carbonic acid, and a considerable quantity of common salt. The presence of chloride of potassium in the leaf but not in the bulb is worthy of remark. It should be understood that as we have no means of deciding in what state of combination the chlorine exists in an ash, it is usual to assign it to the metallic base of soda. Chloride of sodium is therefore usually mentioned; but where the soda is not in sufficient abundance for this purpose, the excess of chlorine is given to potassium. Chloride of potassium *may* exist in many cases; but in these cases it or some other chloride, besides common salt, *must* be present. If the potash of the plant be obtained from chloride of potassium, then it is easy to see why it should be found in the leaves but not in the bulb.

But though the ash of different specimens is in many respects alike, more especially in the bulbs, its per centage is so variable that one bulb might, weight for weight, contain twice as much phosphoric acid or potash as another. A table of the quantity of each substance in a ton of bulb and top will give a clear notion of this :—

TABLE 6.—Mineral Matter (in pounds) in one ton of Turnip-bulb.

No. of Spec.	82	83	84	85	77	86	Mean of the six Specimens.
Variety.	Skirving's Swede.	Skirving's Swede.	Dale's Hybrid.	Dale's Hybrid.	Skirving's Swede.	Green-top White.	
Per Centage of Ash	·75	·76	1·09	·72	·88	·59	..
Silica	·45	·29	·67	·18	·32	·13	·34
Phosph. Ac.	1·56	1·74	2·14	1·74	2·46	1·01	1·77
Sulph. Ac.	2·71	2.66	2·86	1·82	2·22	1·70	2·33
Lime	1·99	2·45	1·58	1·44	2·24	·89	1·76
Magnesia	·55	·56	·61	·31	·48	·29	·47
Perox. Iron	·08	·10	·03	·10	·05	·09	·07
Potash	4·00	4·58	9·04	5·25	7·12	6·43	6·07
Soda	2·48	2·28	1·96	1·09	·98	..	1·46
Chlo. Sodium	1·18	·37	2·44	2·32	1·92	·72	1·49
Chlo. Potass.	..	..	..	..	..	..	..
Total	15·00	15·03	21·33	14·25	17·79	11·25	15.76

TABLE 7.—Mineral Matter (in pounds) in one ton of Turnip-tops.

No. of Spec.	82	83	84	85	77	86	Mean of the six Specimens.
Variety.	Skirving's Swede.	Skirving's Swede.	Dale's Hybrid.	Dale's Hybrid.	Skirving's Swede.	Green-top White.	
Per Centage of Ash	1·97	1·95	1·19	2·25	1·61	1·82	..
Silica . .	3·55	·50	·34	3·69	1·48	·85	1·73
Phosph. Ac.	2·15	2·71	1·22	5·87	2·36	1·29	2·60
Sulph. Ac. .	4·57	5·33	1·79	3·51	2·34	3·20	3·46
Lime . .	12·57	13·26	9·37	12·18	8·64	11·76	11·29
Magnesia .	1·16	1·39	·47	1·79	1·05	1·17	1·16
Perox. Iron	1·33	·29	·16	1·55	·68	·33	·72
Potash . .	5·09	9·08	3·61	6·20	7·34	5·18	6·08
Soda . .	5·49	..	1·23	..	..	..	1·12
Chlo. Sodium	5·48	4·51	4·81	11·40	6·37	4·36	6·15
Chlo. Potass.	..	·91	..	·92	3·53	6·77	2·02
Total .	41·39	38·06	23·00	47·11	33·79	34·91	36·33

From the table it will be seen that Specimen 84, which gave an ash with rather little phosphoric acid, does yet, on account of its large amount of ash, contain more of this acid, when calculated on the turnip itself, than several other specimens. Again, the ash of Specimen 86 was found by analysis to contain much more potash than the other specimens. Calculated, however, in its proportion to the vegetable matter, the potash is brought down to the usual average.

It will be at once noticed that in a ton of one bulb there may be almost twice as much mineral matter as in another, and the same is equally true of the leaf; but it is very singular that if a calculation be made of the mineral matter in the entire crop—that is, in its relative proportions of root and top—much of the discrepancy will disappear.

The following table is calculated so as to exhibit the mineral matter removed by one ton of the whole plant (bulbs and tops), in the proportion of those parts actually ascertained in our experiments. It would seem more scientific to make these calculations upon a decimal quantity of the vegetable substance, such as 10,000 or 100,000 grains, but it is conceived that by referring the mineral matter to a ton of the crop, a double purpose is served: the relation is sufficiently apparent, and numbers of practical application are obtained :—

TABLE 8.—Mineral Matter (in pounds) in one ton of entire crop o Turnips.

No. of Spec.	82	83	84	85	77	86	Mean of the six Specimens.
Variety.	Skirving's Swede.	Skirving's Swede.	Dale's Hybrid.	Dale's Hybrid.	Skirving's Swede.	Green-top White.	
Relation of Bulb to Top	B. 89 at 0·75 Ash T. 11 – 1·97	86–0·76 14–1–95	67–1·09 33–1·19	82–0·72 18–2·35	90–0·88 10–1·61	62–0·59 38–1·82	
Silica . .	0·79	0·32	0·56	0·81	0·44	0·40	0·55
Phosph. Ac.	1·63	1·88	1·83	2·49	2·45	1·12	1·90
Sulph. Ac. .	2·91	3·04	2·52	2·12	2·23	2·27	2·51
Lime . .	3·15	3·97	4·15	3·37	2·88	5·02	3·76
Magnesia .	0·62	0·67	0·56	0·57	0·53	0·62	0·59
Perox. Iron	0·22	0·13	0·06	0·36	0·11	0·19	0·18
Potash . .	4·12	5·21	7·22	5·42	7·14	5·96	5·84
Soda . .	2·81	1·96	1·72	0·89	0·88	0·00	1·38
Chlo. Sodium	1·65	0.95	3·22	3·95	2·37	2·11	2·37
Chlo. Potass.	. .	0·13	..	0·17	0·35	2·57	0·53
Total .	17·90	18·22	21·84	20·15	19.38	20.26	19.61

This table exhibits the highly interesting result, that whatever differences may occur in the quantity and composition of the ash of either bulb or top, taken separately, upon the entire plant, the ash is much more constant: thus in one ton of the entire crop of the specimens here given, the ash is included between the amounts of 18 lbs. and 22 lbs. There is, it is true, still some considerable variation in the proportion of particular substances (more especially of the phosphoric acid), but on the whole it must be concluded that differences in the ash of either part of the plant are in great measure counterbalanced by an opposite condition of the other part of the bulb. It would seem, indeed, as if a certain quantity of mineral matter is distributed through a given weight of the whole plant, without respect to the proportion of the top to the bulb—sometimes the greater proportion being found in the leaves, sometimes in the bulb.

We select three specimens which exhibit most strongly the balance of mineral matter in the bulbs and tops :—

TABLE 9.

Specimen.	Proportion per Ton in lbs.		Ash.		Mineral Matter in a Ton of entire Crops (in lbs.).		
	Bulb.	Top.	Bulb.	Top.	Bulb.	Top.	Both.
84	1501	739	1·01	1·19	15·15	8·79	23·94
85	1837	403	0·72	2·25	13·31	9·06	22·37
86	1389	851	0·59	1·82	8·22	15·48	23·70

This table affords a most singular instance of the distribution of the ash: the mineral matter of Specimen 84 seems to have changed places with that of 86—in the one case its largest amount being in the bulb, in the other in the leaf. It seems truly extraordinary that with such deviating per centages of ash, the final result should be so nearly alike. This is, however, due to the difference not only in the per centage of ash in the bulb and leaf, but also to the proportion between the bulb and top. Were we to make the calculation upon the supposition that the top is the same in all cases, the result would be very different. Let us take the average of 90 of bulb to 10 of top. The results would then be as follows:—

Specimens.	Mineral Matter in a Ton of entire Crops.		
	Bulb.	Top.	Both.
84	20·4	2·7	23·1
85	14·6	5·0	19·6
86	12·1	4·1	16·2

Here all similarity in the final result vanishes, without any uniformity in the mineral matter of the several parts being obtained. The proportion of bulb to top is then one element of the calculation not to be neglected, and the results above given go far to prove the accuracy of our estimations of these quantities. The practical deduction from these facts is highly important. The bulbs or tops of any particular crop may contain a very varying proportion of mineral matter—influenced, in all probability, by its age and other circumstances which have yet to be ascertained; but a given weight of the whole crop will never very greatly vary in its mineral constitution. Any calculations founded upon the constitution of either the bulb or top separately must be taken with very great limitations; suppose, for instance, the tops of the turnips to be left in all cases on the land, but that half of the bulbs (say 10 tons, the whole crop of bulbs being 20 tons) are drawn for consumption by cattle in the yards, the quantity of mineral matter removed from the soil might in one instance be 112 lbs. (Specimen 86), or in another case 213 lbs. (Specimen 84), whereas in a given weight of the whole produce, the mineral matters would be very nearly alike—(202 and 218 lbs.). We have said that this is of practical importance: we should rather say that it is of great importance in all practical experiments which are undertaken for the sake of establishing the rationale of the growth of crops. If it be sought to establish the relative effect of different manures on the crops following that one for which they are applied, it will not do to remove from each piece of land under trial a similar quan-

tity of the bulb. This would appear fair and equal enough, but it would not be so. Any application of the crop that is grounded upon the constancy of its mineral composition must be made upon the entire plant.

In the same way the manure of a ton of any specimen of turnip-bulbs may be of considerably more value than that of a similar weight of another; but for all practical purposes, a given weight of the root and top, in their proper proportions, will always produce an equally effective manure, as far as its mineral constituents are concerned.

It will be seen that the leaves of turnips contain much more common salt (chloride of sodium) than the bulbs. The quantity is considerable in some cases. In Specimen 85 it amounts to $11\frac{1}{2}$ lbs. on a ton, or about 9 ounces on every cwt. of the green tops. May not this circumstance in part explain the action of turnip-tops in causing purging in sheep when they are first turned upon this food from the pastures? The other alkaline salts (such as the phosphates of soda and potash, and organic salts of these bases, oxalate, tartrate, &c., and which are known as purgatives) exist largely in turnip-tops. We shall shortly, in speaking of mangold-wurzel, draw attention again to the influence of salt in turnips and mangold upon the feeding of sheep and cattle with these roots.

Mangold Wurzel or Beet.

The information we have obtained concerning this root extends to a far smaller number of specimens than in the case of turnips. Still it will no doubt be sufficient to give a tolerably correct notion of the mineral characters of the plant. The following table exhibits the relation between those specimens which we have examined:—

TABLE 10.—Water, Ash, &c., in Beet-root.

No. of Spec.	Variety.	Relation of Bulb to Top.		Water and Ash in Bulb.			Water and Ash in Top.		
		Bulb.	Top.	Water.	Ash.	Ash on dry substance.	Water.	Ash.	Ash on dry substance.
106	Yellow Globe	85	15	91·0	1·02	11·32	90	1·40	14·00
107	Long Red .	88	12	91·0	0·64	7·10	90	1·79	17·90
108	Long Red .	80	20	90·0	1·00	10·00	90	1·91	19·10
109	Globe . .	..	..	86·0	0·92	6·60			
110	Globe . .	..	..	84·0	1·54	9·60			

Of the relation of bulb to top we have nothing to say; for the number of cases is inadequate to throw any light upon it. No doubt, however, it is correct as far as the individual instances are

concerned. For the same reason no very decided conclusion is to be drawn concerning the proportion of water; in the three specimens (106, 107, 108) it is remarkably constant both in the bulbs and tops, and were it fair to decide from these we should say that, weight for weight, beet contains *less* solid matter than turnips. The other instances (109, 110) would interfere very much with this constancy; but although we have given the proportion of water as we found it, we confess that the results in those two specimens are somewhat questionable; the leaves were cut off before the roots were sent to us, and some water might have escaped by evaporation from the wounds.

There is nothing to make us doubt that, had a larger number of specimens been examined, the per centage of ash in mangold would have proved equally variable as that of turnip. In fact, in the five cases in the table, one specimen is seen to contain twice as much mineral matter as another.

The per centage of ash of beet does not greatly differ from that of turnips either in bulbs or tops.

The composition of the ash next requires notice. The analyses are placed side by side, in order that a comparison may be instituted between them.

Table 11.—Composition of the Ash of Beet-bulb (in 100 parts).

No. of Specimen.	106	107	108	Mean of the three Specimens.
Variety.	Yellow Globe.	Long Red.	Long Red.	
Per Centage of Ash .	1·02	0·64	1·00	
Silica	2·22	1·40	4·11	2·57
Phosphoric Acid . .	4·49	1·65	3·11	3·08
Sulphuric Acid . .	3·68	3·14	3·31	3·37
Carbonic Acid . .	18·14	15·23	21·61	18·32
Lime	1·78	1·90	2·17	1·95
Magnesia . . .	1·75	1·79	2·79	2·11
Peroxide of Iron . .	0·74	0·52	0·56	0·60
Potash	23·54	21·68	29·05	24·79
Soda	19·08	3·13	19·05	13·75
Chloride of Sodium .	24·54	49·51	14·18	29·41
Chloride of Potassium	..	..	..	..
Total . . .	99·96	99·95	99·94	99·95

Table 12.—Composition of the Ash of Beet-leaf (in 100 parts).

No. of Specimen.	106	107	108	Mean of the three Specimens.
Variety.	Yellow Globe.	Long Red.	Long Red.	
Per Centage of Ash .	1·40	1·79	1·91	
Silica	2·35	2·26	1·35	1·99
Phosphoric Acid . .	5·89	5·19	4·39	5·15
Sulphuric Acid . .	6·54	4·60	6·26	5·80
Carbonic Acid . .	6·92	6·45	6·11	6·49
Lime	8·72	8·17	9·06	8·65
Magnesia . . .	9·84	7·03	9·10	8·66
Peroxide of Iron . .	1·46	0·96	0·48	0·96
Potash	8·34	27·90	27·53	21·26
Soda	12·21	3·01	5·83	7·01
Chloride of Sodium .	37·66	34·39	29·85	33·96
Chloride of Potassium .	..	..	..	..
Total . . .	99·95	99·96	99·96	99·93

It will be seen by the first of these tables that different specimens of beet bulb give an ash very much alike. Nos. 106 and 108 most nearly resemble each other, although of different variety, which would lead us to believe that variety does not here, more than in the case of turnips, exert on the composition of the ash an influence sufficiently great to be observed over the other circumstances of the plant.

The chief features in the composition of the ash are, the large proportion of alkalies present in it as carbonates, but existing in the vegetable itself no doubt in great part in the form of nitrates, which are well known to be constituents of beet. The phosphoric acid, the sulphuric acid, and the lime are found in the mangold bulb ash in smaller quantity than in that of the turnip. The high per centage of common salt in beet is remarkable: in one case it constitutes one-half, in another one-fourth, of the entire mineral matter.

The ash of the three specimens of beet-leaf analyzed is very similar in composition: indeed there is here much more resemblance than in the turnip-leaves. The ash of beet-leaves contained more phosphoric and sulphuric acid, more lime and magnesia, but less alkali, and a smaller amount of alkaline carbonates than that of the bulb. It contains, however, like the bulb, a very considerable quantity of common salt. The ash of both bulb and leaf evidences a partial substitution of soda for potash. A table of the mineral constituents in a given weight of beet will afford us further subject of thought:—

TABLE 13.—Mineral Matter (in pounds) in one ton of Beet-bulb.

No. of Specimen.	106	107	108	Mean of the three Specimens.
Variety.	Yellow Globe.	Long Red.	Long Red.	
Per Centage of Ash .	1·02	0·64	1·00	
Silica	0.51	0·20	0·92	0·54
Phosphoric Acid . .	1·03	0·24	0·70	0·66
Sulphuric Acid . .	0·77	0·45	0·74	0·65
Lime	0·47	0·27	0·49	0·41
Magnesia . . .	0·40	0·26	0·62	0·43
Peroxide of Iron . .	0·17	0·07	0·13	0·12
Potash	5·39	3·10	6·50	4·99
Soda	4·36	0·45	4·27	3·02
Chloride of Sodium .	5·61	7·08	3·17	5·29
Chloride of Potassium	..	..	..	..
Total . . .	18·71	12·12	17·54	16·11

TABLE 14.—Mineral Matter (in pounds) in one ton of Beet-leaf.

No. of Specimen.	106	107	108	Mean of the three Specimens.
Variety.	Yellow Globe.	Long Red.	Long Red.	
Per Centage of Ash .	1·40	1·79	1·91	
Silica	0·75	0·94	0·58	0·76
Phosphoric Acid . .	1·88	2·07	1·88	1·94
Sulphuric Acid . .	2·08	1·84	2·68	2·20
Lime	2·77	3·27	3·88	3·31
Magnesia . . .	3·13	2·81	3·89	3·27
Peroxide of Iron . .	0·46	0·38	0·21	0·52
Potash	2·65	11·16	11·79	7·86
Soda.	3·88	1·20	2·49	2·52
Chloride of Sodium .	12·00	13·75	12·74	12·82
Chloride of Potassium	..	..	..	..
Total . . .	29·60	37·42	40·14	35·20

In Table 13 it will be noticed that the total mineral matter in the bulb of the three specimens is very different. The bulbs of Nos. 106 and 108, 'tis true, agree pretty closely in this particular; but the resemblance does not extend to No. 107. On the other hand, in the leaf (Table 14) Nos. 107 and 108 resemble each other, whilst 106 stands apart. In the bulb of Specimen 107 there is very little phosphoric acid; in the leaf, on the contrary, there is a greater quantity than in the other specimen. Weight for weight, the leaves are considerably richer in this im-

portant ingredient than the bulbs; they also contain a very much larger proportion of magnesia. The alkalies predominate in the bulbs, whilst common salt, although abundantly present in both, is found in larger quantity in the leaf as it is in that of the turnip.

A table of the mineral contents of a ton of entire beet, bulb and top, will show us how far the differences between the specimens are destroyed by the joint effect of the bulb and leaf ash.

TABLE 15.—Mineral Matter (in pounds) in a ton of entire crop of Beet.

No. of Specimen.	106	107	108	Mean of the three Specimens.
Variety.	Yellow Globe.	Long Red.	Long Red.	
Relation of Bulb to Leaf . . .	B. 85 at 1·02 ash. L. 15 „ 1·40 „	88–0·64 12–1·79	80–1·00 20–1·91	
Silica	0·54	0·29	0·86	0·56
Phosphoric Acid . .	1·16	0·50	0·94	0·87
Sulphuric Acid . .	0·96	0·62	1·12	0·90
Lime	0·82	0·63	1·17	0·87
Magnesia	0·81	0·59	1·28	0·89
Peroxide of Iron . .	0·21	0·11	0·13	0·15
Potash	4·98	4·07	7·56	5·54
Soda	4·29	0·54	3·91	2·91
Chloride of Sodium .	6·57	7·88	5·09	6·51
Chloride of Potassium	..	..	..	..
Total . . .	20·34	15·23	22·06	19·20

Here Specimen 107 is found to be still unlike its neighbours: it contains, indeed, a smaller amount of all the ingredients with the exception of common salt, which forms one-half of the total mineral matter of the plant. Twenty tons of beet (including the tops) might, according to this calculation, take up from the soil $1\frac{1}{2}$ cwt. of common salt. It is difficult to say whether this is really essential to the plant; we have no alternative, however, at present but to believe that it is; and the resemblance of the three specimens in this particular substance justifies such a belief. It is plain, then, that a top-dressing of salt may benefit either turnips or beet; but especially the latter, by supplying a substance absolutely required. A dose of 3 cwt. to the acre will not be considered large when it is known that half of it is required by a good crop, and from its solubility much must be wasted before the plant can appropriate it. The quantity of common salt in turnips and beet demands our serious attention, from the influence which it must exert upon the constitutions of animals which are fed with these roots.

Let us suppose, with Mr. Stephens ('Book of the Farm'), that an ox eats $1\frac{3}{4}$ cwt. of turnips each day, and that a cow is allowed one-third of this quantity, or about 65 lbs. a day; and that sheep on the average of age and breed would eat (at least) 28 lbs. of turnips daily. These numbers may not accord with every man's experience, and they are merely stated for sake of argument. Any correction can easily be made if they are not considered as fair averages.

Now $1\frac{3}{4}$ cwt. of turnip bulb will contain on an average rather more than 2 ounces of salt. The same quantity of beet bulb will contain about $7\frac{1}{2}$ ounces of salt. 65 lbs. of turnip bulb, the daily allowance of a cow, will contain something less than 1 ounce of salt. The same weight of mangold will afford to the animal eating it more than 2 ounces of salt.

These calculations are founded upon the presumption that cattle would generally be furnished with the clean bulb without the leaves, which are left on the field. It must be otherwise, however, in the case of sheep. When a flock of sheep are first turned upon the turnips they will commence with the tops.

28 lbs. of turnip-tops contain on an average about $1\frac{1}{4}$ ounce of salt: they may contain (Spec. 85, table 7) twice this quantity, or $2\frac{1}{2}$ ounces. 28 lbs. of the entire crop will usually afford about half an ounce of salt, and the same quantity of the clean bulb of course not so much.

Supposing sheep to be turned upon beet, and that they consumed an equal amount of this root as of turnips, then in 28 lbs. of leaf they would always find $2\frac{1}{2}$ ounces of salt; and a similar amount of the bulb, or of the bulb and leaf together, would on the average contain $1\frac{1}{2}$ ounce of this substance.

Of the action of salt upon the animal economy, and of the advantages which are supposed to be derived from a free supply of this substance to sheep and cattle, we do not pretend to be competent judges; our province is to point out that the arguments which will apply to salt given separately, must also be held good in the case of turnips or mangold, which equally convey this condiment into the stomach of those animals which are fed upon them.

It is possible that a farmer would think half a pound of salt rather a large dose to give day by day for weeks together to an ox—yet such is the allowance which the animal would daily receive in his food, supposing the latter to be mangold-wurzel.

There can be little doubt that a moderate exhibition of salt will conduce to the healthy exercise of the digestive functions, but when largely administered it is considered to impair the secretion of the liver, a result which, however it may conduce to the formation of fat in an animal, must be considered as implying an unhealthy

condition of the system, to be discouraged except for the specific purpose of fattening an animal at the expense of its general well-being. As far more deserving of attention than anything we can say on this subject, we would beg to present the opinion of Mr. Robinson, the experienced Professor of Veterinary Surgery at the Agricultural College of Cirencester, on the use of salt.* This gentleman says, "I have for many years been perfectly convinced that salt allowed in quantity is highly prejudicial to all breeding animals, inasmuch as it has a direct influence in greatly diminishing the necessary supply of milk for the immediate sustenance of the young animal; hence salt is the best medium to 'dry' a cow of her milk, and ewes would also be benefited by free access to this substance for one week when their lambs are taken from them.

"I am also convinced that salt has the effect of diminishing the secretion of the liver, and that it is from this cause that the good effects of salt are so obvious in the *feeding* of animals. It is well known that incipient disease of the liver is favourable to the production of fat.

"When lambing ewes are allowed a large quantity of turnips with a small amount of other food through the winter, abortion is a frequent occurrence—their supply of milk is very deficient, and their lambs are dropped of very various sizes and far from healthy. If the ewes are allowed free access to salt the lambs are still more unhealthy, and many die from indigestion and disease of the liver. The mortality of the lambs in these cases may, I think, be fairly attributed to the amount of salt taken by the dam; for admitting that a small portion only is directly given them, the quantity positively taken in their food in the turnips is somewhat considerable, as you pointed out to me from your analysis. This is a point—the normal or natural quantity of salt—contained in the different roots, &c. consumed by animals as food, which will throw much light upon this most important branch of agriculture. That the use of salt is highly beneficial to certain stock and at certain times, there cannot be a doubt; but from my own knowledge it is no less equally true that the too free and indiscriminate use of it to all stock and at all times is highly prejudicial."

We must leave this opinion to the judgment of the readers of the Journal—it is that of an experienced and careful observer and therefore entitled to very considerable reliance. It would seem perfectly safe, however, to say that, supposing Mr. Robinson

* The above (which is published by the permission of my friend, Mr. Robinson) was hastily written in reply to my wish, that he should state in a few words the result of his experience on this subject. I had some time since mentioned to him the large quantity of salt found in the turnip and beet, which it appeared was in consonance with his own observation of their effects upon the milk of cows and ewes.—J. T. W.

to be correct in his view of the action of salt, the free use of turnips, and still more of mangold, must lead to similar results. Here again the same remark will apply, as that which was made relative to the varying value of turnip crops raised by artificial manures.

Let us suppose that it is not denied that salt is injurious to cows in calf or milch-cows, and to ewes before and after the lambing season; and let us further admit that, from the quantity of salt they contain, turnips and mangold must be chargeable with the same prejudicial effects. Are we then necessarily and at once to be deprived of these valuable articles of food in so very considerable a portion of their present application? Certainly not; but it behoves us to inquire how we can do away with the evil. Fortunately common salt is a very soluble body; and although steeping of the bulbs in water would not, we fear, remove it, it is most probable that boiling or steaming the turnips would have the effect of dissolving out much of the objectionable substance.* In the latter method it would be necessary that all the condensed steam should have free opportunity of escaping from the turnips; and the more minutely these were divided the more perfect would be the separation of the salt. We do not recommend these plans; we do not even say that any precaution of the kind is necessary; but if it be so, some such plan would save the necessity of discontinuing the use of turnips and mangold in the particular cases before mentioned.

Of Carrots.

The only variety of carrot which we have examined is the White Belgian. It would of course be well to possess analyses of other important varieties of this root, and we shall at a future time make good the deficiency. A review of the crops already described, and a careful comparison of those whose peculiarities we are about to discuss, would, however, make it questionable whether any great results would follow from the examination of other varieties.

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* Boussingault has lately published ('Annales de Chimie et de Physique,' May 1847) an account of some experiments made by him on the use of salt. Two lots of young beasts were fed during about four winter months, with an unlimited supply of hay and beet; to the one lot salt was given. Boussingault found that the quantity of food consumed, and the live weight produced was the same in both instances, and no way influenced by the use of salt with their food; the animals which received salt drank, however, nearly twice as much water daily. He attributes absence of any effect from the use of salt in this case to the quantity of that substance actually administered in the food. The above observations were written before we had seen an account of Boussingault's experiments.

The following table gives a comparative view of the specimens of root examined:—

TABLE 16.—Water and Ash in Carrots.

No. of Spec.	Variety.	Relation of Root to Leaf.		Water and Ash in the Root.			Water and Ash in the Top.		
		Root.	Leaf.	Water.	Ash.	Ash on dry.	Water.	Ash.	Ash on dry.
111	White Belgian Carrot	..	..	85·0	0·96	6·40			
112	Ditto	76	24	85·0	0·77	5·12	75·0	5·32	21·30
113	Ditto	81	19	87·0	0·82	6·30	76·0	4·20	17·50
114	Ditto	81	19	85·0	0·92	6·10	82·0	2·85	15·80
115	Ditto	..	..	88·0	1·06	8·80			
116	Ditto	..	..	86·0	0·95	6·80			

The proportion of leaf would appear rather larger than in the turnips or mangold-wurzel; but it is unsafe to judge from so limited a series.

The water in the roots is, if anything, less than in beet or turnip, and most certainly so in the leaf—the leaf of carrots should, therefore, be more valuable.

The ash in the root is no way different in quantity from that of either of the root crops just mentioned, but that of the leaf is seen to be very much greater. This is important, and will be noticed again almost immediately. The analyses of five specimens of the root ash are before given and included in the following table:—

TABLE 17.—Composition in 100 parts of the Ash of Carrot-roots.

No. of Specimen . .	112	113	114	115	116	Mean of the five Specimens.
Variety.	White Belgian.	White Belgian.	White Belgian.	White Belgian.	White Belgian.	
Per Centage of Ash .	0·77	0·82	0·92	1·06	0·95	
Silica	0·76	1·10	1·92	1·16	1·00	1·19
Phosphoric Acid . .	8·37	7·86	9·17	8·09	9·27	8·55
Sulphuric Acid . .	6·34	6·95	9·49	5·37	4·59	6·55
Carbonic Acid . .	15·15	17·72	19·11	17·69	16·86	17·30
Lime	9·76	8·26	11·89	6·08	8·17	8·83
Magnesia . . .	3·78	3·20	5·89	3·44	3·48	3·96
Peroxide of Iron . .	0·74	1·66	1·37	1·17	0·59	1·10
Potash	37·55	28·00	21·40	41·97	33·29	32·44
Soda.	12·63	17·53	14·21	8·18	15·06	13·52
Chloride of Sodium .	4·91	7·65	5·52	6·82	7·62	6 50
Chloride of Potassium	..	..	..	..	..	..
Total . . .	99·99	99·93	99·97	99·97	99·93	99·94

These analyses are, in many respects, very closely alike; the chief difference to be observed occurs in Specimen No. 114, which appears to contain more of the sulphate, phosphate, and carbonate of lime, but less potash and soda. Throughout the specimens there is an indication of the equivalency or substitution of soda for potash.

The ash of carrot-root very nearly resembles that of turnips; but in place of much of the sulphates which occur in the latter, carrot-root ash affords, upon analysis, a more considerable quantity of carbonates. It will perhaps be better, however, to defer any additional remarks on this subject till the analyses of each of these roots can be placed side by side, which shall shortly be done.

The table which follows exhibits the composition of the ash of carrot leaves:—

TABLE 18.—Composition in 100 parts of the Ash of Carrot-leaves.

No. of Specimen . .	112	113	114	Mean of the three Specimens.
Variety.	White Belgian.	White Belgian.	White Belgian.	
Per Centage of Ash .	5·32	4·20	2·85	
Silica	7·39	1·83	4·48	4·56
Phosphoric Acid . .	2·55	1·12	1·34	1·67
Sulphuric Acid . .	6·68	5·47	5·86	6·20
Carbonic Acid . .	16·29	22·25	14·92	17·82
Lime	34·98	29·50	33·44	32·64
Magnesia	2·50	3·03	3·23	2·92
Peroxide of Iron . .	4·06	0·90	2·26	2·40
Potash	7·28	7·53	6·55	7·12
Soda.	9·46	10·69	12·76	10·97
Chloride of Sodium .	8·77	17·14	15·11	13·67
Chloride of Potassium	..	..	..	..
Total . . .	99·96	99·96	99·95	99·97

The ash of the leaf does not greatly vary in composition in these instances. It contains but little phosphoric acid, but then its per centage is high; as in the turnip and the mangold so in the carrot, chloride of sodium is a much more considerable ingredient in the leaf-ash than in that of the root.

The ash of carrot-leaf is peculiar in one respect; of the alkalies potash and soda, the latter greatly predominates. The same thing occurs in one specimen of beet-leaf (Table 12, Specimen No. 106), and in one specimen of turnip-top (Table 5, Specimen No. 82), but in no other cases that we have yet met with. This is in reality an important as well as a singular circumstance. The alkali soda is much more available for agricul-

tural purposes than potash, especially as the results we have obtained * would induce a belief that a plant can obtain this alkali from common salt (the *commonest* of all salts). If any plant be found to content itself with this alkali, such plant will undoubtedly be more easy of artificial culture than others which require potash and refuse to take soda instead of it: it is not said that this is the case with the carrot, but attention is drawn to the uniformity of the result in the case of the leaves.

The mineral matter of a given weight of carrots will be seen by the following table:—

TABLE 19.—Mineral Matter in one ton of Carrot-roots (in pounds).

No. of Specimen	112	113	114	115	116	Mean of the five Specimens.
Variety.	White Belgian.	White Belgian.	White Belgian.	White Belgian.	White Belgian.	
Per Centage of Ash	0·77	0·82	0·92	1·06	0·95	
Silica	0·13	0·20	0·40	0·27	0·21	0·24
Phosphoric Acid	1·44	1·44	1·89	1·92	1·97	1·73
Sulphuric Acid	1·09	1·27	1·95	1·27	0·98	1·31
Lime	1·68	1·51	2·45	1·44	1·79	1·77
Magnesia	0·65	0·58	1·21	0·82	0·74	0·80
Peroxide of Iron	0·13	0·30	0·28	0·28	0·12	0·22
Potash	6·34	5·14	4·41	9·96	7·09	6·59
Soda	2·18	3·21	3·04	1·94	3·20	2·71
Chloride of Sodium	1·32	1·40	1·14	1·62	1·62	1·42
Total	14·96	15·05	16·37	19·52	17·72	16·79

TABLE 20.—Mineral Matter in one ton of Carrot-leaves (in pounds).

No. of Specimen	112	113	114	Mean of the three Specimens.
Variety.	White Belgian.	White Belgian.	White Belgian.	
Per Centage of Ash	5·32	4·20	2·85	
Silica	8·80	1·72	2·85	4·46
Phosphoric Acid	3·03	1·05	0·85	1·64
Sulphuric Acid	7·96	5·15	3·72	5·61
Lime	41·69	27·77	21·27	30·24
Magnesia	2·98	2·71	2·05	2·58
Peroxide of Iron	4·84	0·81	1·42	2·36
Potash	8·67	7·09	4·17	6·64
Soda	11·28	9·62	8·12	9·67
Chloride of Sodium	10·45	15·40	9·61	11·95
Chloride of Potassium	..	..	..	..
Total	99·70	70·62	54·06	75·15

* We have not mentioned the data upon which this belief is grounded; indeed, in such questions it is better to defer a final decision until a greater mass of evidence is collected.

That the numbers in the 1st table should bear a general resemblance to each other is not singular, inasmuch as neither the per centage of ash nor its composition is subject to much variation.

That the 2nd table should exhibit considerable variation is evident from the per centage of ash being so dissimilar, more particularly in the 1st and 3rd columns.

There is a certain consistency even here; the per centage of ash in the leaf of the three specimens is, in each case, the converse of that in the bulb. The higher the ash in the leaf the less is the quantity in the bulb. This circumstance, however, is not sufficient to overcome the preponderance of ash in No. 112, as will be seen by the following table:—

TABLE 21.—Mineral Matter in a ton of entire crop of Carrot.

No. of Specimen . .	112	113	114	Mean of the three Specimens.
Variety.	White Belgian.	White Belgian.	White Belgian.	
Relation of Root to Leaf {	R. 76 at 77 ash L. 24 „ 5·32 „	81– ·82 19–4·20	81– ·92 19–2·85	
Silica	2·29	0·50	0·89	1·22
Phosphoric Acid . .	1·84	1·37	1·69	1·63
Sulphuric Acid . .	2·80	2·03	2·30	2·37
Lime	11·68	6·75	6·21	8·21
Magnesia	1·20	1·00	1·37	1·19
Peroxide of Iron . .	1·30	0·40	0·50	0·73
Potash	6·91	5·54	4·35	5·60
Soda	4·44	4·48	4·06	4·33
Chloride of Soda . .	3·60	4·20	2·84	3·55
Chloride of Potassium .	..	..	..	..
	36·08	26·27	24·21	28·83

The 2nd and 3rd columns of this table are, in many respects, very similar both as to each individual substance and in the final result. Specimen No. 113 contains rather more potash, soda, and common salt than No. 114; but Specimen No. 112 is unlike either of the others, more especially in the total quantity of mineral matter: this arises from two causes; its leaf has a very large ash, and there is a greater proportion of the leaf in the entire plant. Were the calculation based upon the supposition that the leaf is in the same proportion to the bulb, as in the other instances, one-half of the total difference would be done away with; but, besides that candour would not admit of a proceeding like this, there would still be a great excess of mineral matter in No. 112.

We would rather, however, be inclined to attribute this want of

correspondence to some accidental cause,* than to consider it as destructive of the principle which we have before attempted to elucidate; namely, that in the entire plant the mineral matter will be found far more constant in quantity and composition than in either the root or the leaf taken separately—the variations which occur being counteracted by the alteration of the per centage of ash or of the proportion of root to leaf.

One important point in reference to the mineral composition of the carrot still remains to be noticed. A comparison of the mineral contents of a ton of the entire crop of beet, turnip and carrot, clearly shows (see page 199) that the carrot is fully as rich in the more important elements of mineral fertility as either of the other crops—indeed, if anything, rather surpasses them; for although it contain on the average a very slight proportion less of phosphoric acid than turnips, yet it will be seen on the other hand to possess more magnesia and more alkali than either mangold-wurzel or turnip. For most practical purposes, however, we may consider these three roots as equal in mineral wants and peculiarities. The carrot, then, requires as much mineral food as the turnip or beet-root. But this being the case,

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* The analysis of the leaves is subject to a source of error to which that of the roots is not open; the leaves are frequently not quite free from dirt, which they have acquired from various causes. Every effort is made to cleanse them perfectly, but the difficulty of accomplishing this is very great; and when it is considered how small is the proportion of ash in comparison with the vegetable substance operated upon, it is easy to see how the quantity of the former may in spite of all precautions be sensibly augmented by small portions of foreign matter, which from their minuteness have escaped the strictest scrutiny. To this cause we are inclined to attribute the very uniform relation which is observable in the analyses of the ash of the leaf between the silica and peroxide of iron—wherever the one is large, the other is large also. Now, as we have never been able to discover alumina in very carefully prepared ashes (such as those of seeds), we have not thought it worth while to embarrass our methods of analysis by the separation of this body (should it happen to be present) from peroxide of iron, which itself is a substance of little importance, and sometimes scarcely detectible from the excessively minute quantities of it which are present in the ash—as may be seen by many of our analyses—under the head of peroxide of iron may sometimes then be included a little alumina, and it is precisely these substances and silica, which a want of perfect cleanliness of the leaf would introduce.

In the present instance it is highly probable that this source of error may have interfered; for, by reference to the analysis, it will be seen that the silica and peroxide of iron are both unusually high. It must, however, be remembered that any accidental impurity of this kind only affects the quantity of those substances of which any portion is so introduced: if silica only is accidentally introduced, this will make no difference in the quantity of any other body (as phosphoric acid or magnesia) in a given weight of the vegetable, although the composition of the ash in 100 parts is thereby altered.

how comes it that we can raise good crops of carrots without manure where, if turnips were planted, a failure must be inevitable? Carrots are constantly raised without manure, at all periods of the rotation, and in all soils, *provided they be deep enough.* This, we firmly believe, is the circumstance which will afford an explanation of the readiness with which a crop of carrots is obtained; it is never meant that carrots will not be the better for manure—on the contrary, no doubt a little assistance in forming their leaves and roots will be invaluable to them; but it cannot be denied that common observation is in favour of the position we now wish to make good, that carrots will grow to a crop where beet and turnips will not. Several instances have been given in the preceding pages of crops of 20 or 25 tons grown without manure. Now, it cannot be thought that the carrot has less need of vegetable food than other root-crops; nor certainly must it be said that it does not need so much mineral food as the beet or the turnip, since our analyses prove that it does. The carrot requires as much food, both mineral and vegetable, as either of these crops; and the sole difference lies in its powers of obtaining that food. We would hardly like to say that it has more facilities for the collection of food from the atmosphere, although its serrated leaves might justify such a belief; but it undeniably throws down its roots to a greater depth in search of mineral nourishment—hence the supplies which enable it to vegetate on a poor soil, provided only that the subsoil be good. A stony subsoil is unsuitable to the carrot because of the mechanical obstruction to its roots; but in a good deep clay its long taper roots have been traced to a depth of 10 feet or more, and from this depth they convey to the surface all those mineral riches which are indispensable to the growth of the plant which collects, and beneficial and necessary to the crop which succeeds it. The carrot, then, will yield a crop without manure; not that it does not require the rarest mineral food, but simply because it has independent resources for the acquisition of that food. Is it not, then, worth while to consider whether its cultivation is carried to the extent that it might be? Were it a crop not requiring mineral nourishment, then its cultivation would be worse than useless, for we have analogy with us for believing that the most valuable food for animals is that which in its own growth has drawn most largely on the resources of nature. It must be so, indeed, for in the animal economy matter is only appropriated ("assimilated" is the term); it is never built up from its elements—in order, therefore, that the complex principles of the animal frame should be formed, the food must be complex; and so far as research has yet gone, it is a rule which admits of no exception, that the most highly complex and at the same time most eminently nourishing vegetable substances (gluten, vegetable albumen,

casein, &c.) are associated with the most valuable mineral elements of vegetation, phosphorus, magnesia, and the alkalies. No plant, therefore, which was wanting in those mineral matters could by any possibility be valuable in the feeding of stock, both from the circumstances just mentioned and from the absence of the bodies which are required for the formation of bone.

And again, a crop deficient in mineral matters itself would do but little for the crop succeeding it; it would add nothing to the mineral resources of the soil. This is indeed too much the case with the turnip; it does not labour; it feeds if you give it food, but it remains a stunted and sickly plant unless it readily meet with a supply for its wants. It is, however, no little recommendation to the turnip that mineral nourishment is necessary for it, because its imperative demands being supplied, provision is made for a double supply to the white crop, mineral and vegetable sustenance being in this manner supplied to it.

The carrot, on the other hand, is no way less valuable as food for stock; indeed it may be questioned, from the greater quantity of solid matter which our analyses indicate, whether it would not be more valuable, weight for weight, than turnips. It is said to be much relished by stock, and its chemical character would recommend it as an easily digestible nutritious diet. There may be practical objections to its more extensive introduction into field culture, for it is said to be an expensive crop in cultivation. One point must be borne in mind—the carrot, though it gets food from the subsoil, does not seek it all there; it of course exhausts the surface soil as well, and it must in consequence be eaten on the spot, or if taken to the yard, the manure must be returned, which is the same thing in the end; the crop must not be sold off the farm without return of any kind. When it is considered that a crop of carrots of 16 or 17 tons, with 3 tons of leaves, will take from the soil about 30 lbs. of phosphoric acid, 50 lbs. sulphuric acid, 22 lbs. magnesia, 1 cwt. of potash, $\frac{3}{4}$ cwt. of soda, and 66 lbs. of common salt—a great deal more of these bodies than is removed by the largest grain crops—it may be believed that, however great a portion of this may be obtained from the subsoil, much must be derived from the available working soil, if indeed it exist there.

We think that it will be needless to offer any apology for occupying the pages of the Journal with one or two more tables exhibiting comparative views of the composition of the roots which have been described; such tables will serve to place the whole subject in review, and help to the formation of general conclusions. The following table exhibits the average composition of the ash of turnip, beet, and carrot. It must be remembered that the numbers are the results of six analyses of the bulb and six of the top of turnips—of three analyses of the bulb, and three

of the top of beet—and five analyses of the root, and three of the top of carrot. The numbers are of course provisional—that is, they may be modified slightly by future researches; but, as practical data, they may be regarded as sufficient to establish the mineral composition of the several roots.

TABLE 22.—Comparative View of the Composition (in 100 parts) of the Ash of Turnips, Mangold, and Carrot (the averages of the Analyses).

	Bulb.			Top.		
	Turnip.	Mangold.	Carrot.	Turnip.	Mangold.	Carrot.
Silica	1·81	2·57	1·19	3·99	1·99	4·56
Phosphoric Acid	9·85	3·08	8·55	6·17	5·15	1·67
Sulphuric Acid	13·12	3·37	6·55	8·43	5·80	6·20
Carbonic Acid	11·96	18·32	17·30	9·98	6·49	17·82
Lime	9·93	1·95	8·83	28·49	8·65	32·64
Magnesia	2·61	2·11	3·96	2·81	8·66	2·92
Peroxide of Iron	0·46	0·60	1·10	1·68	0·96	2·40
Potash	34·10	24·79	32·44	15·21	21·26	7·12
Soda	7·96	13·75	13·52	2·84	7·01	10·97
Chloride of Sodium	8·13	29·41	6·50	15·30	33·96	13·67
Chloride of Potassium	..	..	..	5·04	..	..
	99·93	99·95	99·94	99·94	99·93	99·99

Such are the general features of the mineral matter considered without reference to the quantity of it existing in the plants; but this is not the most important point connected with this subject.

In comparing one plant with another a knowledge of the composition of the ash is only of value as it serves to calculate the mineral matter in relation to a given weight of the plant—the following table affords this information:—

TABLE 23.—Comparative View of the Mineral Matters contained in one ton of Turnip, Mangold, and Carrot (the average of all the Analyses).

	In one Ton of the Bulb.			In one Ton of the Top.			In one Ton of the entire Plant.		
	Turnip.	Mangold.	Carrot.	Turnip.	Mangold.	Carrot.	Turnip.	Mangold.	Carrot.
Silica	0·34	0·54	0·24	1·73	0·76	4·46	0·55	0·56	1·22
Phosph. Acid	1·77	0·66	1·73	2·60	1·94	1·64	1·90	0·87	1·63
Sulph. Acid	2·33	0·65	1·31	3·46	2·20	5·61	2·51	0·90	2·37
Lime	1·76	0·41	1·77	11·29	3·31	30·24	3·76	0·87	8·21
Magnesia	0·47	0·43	0·80	1·16	3·27	2·58	0·59	0·89	1·19
Perox. of Iron	0·07	0·12	0·22	0·72	0·52	2·36	0·18	0·15	0·73
Potash	6·07	4·99	6·59	6·08	7·86	6·64	5·84	5·54	5·60
Soda	1·46	3·02	2·71	1·12	2·52	9·67	1·38	2·91	4·33
Chlor. Sodium	1·49	5·29	1·42	6·15	12·82	11·95	2·37	6·51	3·55
Chlor. Potass.	..	..	..	2·02	..	..	0·53	..	..
	15·76	16·11	16·79	36·33	35·20	75·15	19·61	19·20	28·83

The columns of this summary must tell their own tale—they are replete with useful information, which will be more easily furnished by inspection than by any description that could be offered. We may simply say that, whilst they show a greater similarity in mineral composition between the three roots than could by possibility have been anticipated, the points of difference are well worthy of attention.

The Jerusalem Artichoke.

We are not acquainted with any very certain statistics of the produce of this plant; and in order to calculate its power to exhaust the soil, the proportion of stem and leaves to tuber should be known. It is observable by the analysis that the ash of the tuber contains very much potash, and far more phosphoric acid than turnips, beet, or carrot. The quantity of ash is also considerable.

The mineral composition of the tuber of the Jerusalem artichoke may be thus expressed:—

TABLE 24.—Mineral Matter (in lbs.) in one ton of the Tuber of the Jerusalem Artichoke.

Silica	0·61
Phosphoric acid	6·81
Sulphuric acid	1·51
Lime	1·34
Magnesia	0·52
Peroxide of iron	0·18
Potash	22·40
Soda	—
Chloride sodium	—
Chloride potassium	1·96
	35·33

Here it will be seen that, weight for weight, this vegetable contains nearly four times as much phosphoric acid, and three times as much alkali, as turnips, beet, or carrot. The stems and leaves are, in proportion to the tubers, too small to be of great importance in the calculation; and, as we have just said, we do not possess at present the data necessary to include them. The stems will, however, remove a notable quantity of potash. Taking into consideration the large produce of this plant, and the little manure or cultivation required by it, we are at a loss to see where it obtains all this alkaline phosphate, unless, like the carrot, it is possessed of superior powers of acquiring mineral sustenance.

Beans and Peas.

The analyses of these plants, before given, are only intended to point out their general characteristics. We hope, in a subsequent report, to present a very full account of both, as crops from the same seed are at the present moment being raised in different localities for the purposes of this research.

With the caution that some modifications of the composition of these legumes may be introduced by future analyses, we may venture to place the results side by side for comparison.

TABLE 25.—Comparative View of the Composition of the Ash of Beans and of Peas grown on Chalk and Clay.

	Peas.		Beans.	Pea Straw.		Bean Straw.
	On Chalk.	On Clay.	On Clay.	On Chalk.	On Clay.	On Clay.
Per Centage of Ash .	1·97	2·25	2·37	7·52	7·96	4·97
Silica	1·76	0·84	0·42	2·53	1·94	2·61
Phosphoric Acid . .	24·20	28·85	28·72	1·31	1·23	0·49
Sulphuric Acid . .	4·70	5·85	3·05	1·85	2·26	1·40
Carbonic Acid. . .	3·18	2·12	3·42	30·33	29 03	25·32
Lime	6 97	4·55	5·20	46·92	36·46	19·85
Magnesia	6·66	6·96	6·90	8·36	5·73	2·53
Peroxide of Iron . .	0·25	trace	trace	1·14	0·73	0·61
Potash	44·02	41·50	51·72	3·87	12·68	32·85
Soda	..	5·02	0·54	1·86	0·24	2·77
Chloride of Sodium .	8·23	4·30	..	1·76	9·66	11·54
Total . .	99·97	99·99	99·97	99·93	99·96	99·97

In examining this table we are struck with the very great similarity between peas and beans, more especially the specimens grown on the same soil. They are indeed as nearly alike as the two peas themselves. The ash of bean-straw contains more potash than that of pea-straw.

One particular feature about beans and peas is, that neither the grain or straw contains a notable quantity of silica. Again, their straw contains only a very small quantity of phosphoric acid.

The produce of beans and peas is excessively variable. The fairest way to compare the amount of exhaustion produced by the two crops will be perhaps to make a calculation on equal amounts of crop. Let us suppose that the produce of an acre, in each case, would be in grain 1 ton, which is equal to 35 bushels of peas at 64 lbs., and 34 bushels of beans at 66 lbs. to the bushel (rather a high estimate). The straw in each case is taken at the

proportion of the samples analyzed. It is not supposed that the produce of beans and peas should be the same on the same soil, but these numbers will serve for the foundation of a calculation. The following would then be their relative composition:—

TABLE 26.—Comparison of Mineral Matter in Beans and Peas—both on Clay Soil.

	One Ton of Peas.	One Ton of Beans.	2989 lbs. of Pea-Straw.	2270 lbs. of Bean-Straw	Entire Crop Peas.	Entire Crop Beans.
Silica	0·42	0·22	4·62	2·95	5·04	3·17
Phosphoric Acid . .	14·43	15·23	2·93	0·55	17·36	15·78
Sulphuric Acid . .	2·93	1·62	5·38	1·58	8·31	3·20
Lime	2·28	2·75	86·80	22·25	89·08	25·00
Magnesia	3·48	3·66	13·62	2·85	17·10	6·51
Peroxide of Iron . .	..	..	1·74	0·69	1·74	0·69
Potash	20·75	27·40	30·18	36·96	50·93	64·36
Soda	2·51	0·28	0.57	3·13	3·08	3·41
Chloride of Sodium .	2·15	..	23·00	13·88	25·15	13·88
Total . .	53·15	51·16	168·84	84·84	207·79	136·00

The difference between the beans and peas, so far as the grain is concerned, is very trifling. Nor are the numbers for the entire crop very dissimilar. A crop of peas will require more lime and magnesia, but less alkali, than beans. Peas therefore should flourish on a light calcareous loam—beans on stiff clay. The trifling quantity of silica removed in these crops is the all-important point. It will be seen by reference to our last paper (*Journal*, vol. vii. p. 674), that a crop of wheat is in no other way more exhausting to the soil than in requiring a great quantity of silica, which beans and peas do not want. Beans, indeed, are known to be a good preparation for wheat, and they seem to follow it with equal advantage. It appears to us that this may be in great measure due to the alkali contained in beans. In explaining the benefits of rotations on chemical principles, it is usual to say that one crop may follow another with advantage because it requires a different kind of mineral food. A plant, that is, which contains but little alkali would best precede or follow one that drew largely upon the soil for potash. This, no doubt, is true, but something more may be added to it. One crop may really not only dispense with mineral nourishment required by another, and therefore leave it for the benefit of its successor, but it may be active in the preparation of such food for the following crop. This, we believe, is the case with beans in reference to wheat or barley. A crop of beans or peas requires nearly as much phosphoric acid, and a great deal more potash,

than wheat; but it must be remembered that the potash of clay soils exists in them, as silicate of potash derived from the felspar, &c., of the disintegrated granitic rocks, to which the clay owes its origin. The silicate of potash, in felspar, is composed of silica and potash in tolerably equal quantity; but a crop of wheat takes off 83 parts of silica for every 14 parts of potash, so that, to obtain all the silica it requires, it liberates more potash than it has any need of. A crop of beans just reverses this process. It removes from the soil 70 parts of alkali for every 5 parts of silica. It is then almost indifferent which of the plants comes first. The one which follows in the rotation finds potash (if it be beans), or silica (if wheat), ready prepared for it. We venture to suggest that this may in great part be the reason why wheat and beans follow each other without either appearing to suffer from exhaustion produced by the crop preceding it.

It will be seen that weight for weight beans require more potash both in the straw and grain. This is partly perhaps the reason that they thrive on stiffer land than is necessary for peas.

On the Methods of supplying the Mineral Matters for the Root Crops.

We have no intention of discussing under this head the different methods of raising crops of roots by artificial manures: such a subject belongs more to a treatise on manures than to the present report. It is only here necessary to allude to the quantities of different compounds which must be added to the soil if we wish to furnish the crop artificially with all the substances it requires.

Let us suppose, then, that we have a soil "at zero" (so to speak) in mineral constitution,—in other words, that it is so poor as regards phosphoric acid, sulphuric acid, magnesia, and the alkalies that we could not depend upon it to supply any portion of these bodies to the growing plant. This is a purely supposititious case, for it may well be doubted whether such a soil exists on the face of the earth; but it will serve to illustrate our meaning. Let us imagine, then, that we have to provide on a soil so barren as this for the growth of a crop of turnips, mangold-wurzel, or carrots, and that we seek to raise a large crop of either of these roots, say 20 tons of clean bulb; the question is, "What mineral matters must we add to the soil to supply the requisite food for the expected crop?" It is not necessary here to repeat the arguments by which we have arrived at the conclusion that the plant requires these inorganic matters, and will not grow without them. This is taken for granted.

Twenty tons of bulbs and four tons of tops will require the following quantities of the different mineral matters:—

	Turnips.	Mangold-Wurzel.	Carrots.
Phosphoric acid . .	45 lbs.	21 lbs.	39 lbs.
Sulphuric acid . .	50 ,,	22 ,,	57 ,,
Lime	90 ,,	21 ,,	197 ,,
Magnesia	14 ,,	22 ,,	29 ,,
Potash	140 ,,	133 ,,	134 ,,
Soda	33 ,,	70 ,,	103 ,,
Chloride of sodium .	57 ,,	160 ,,	85 ,,

Now it is to be observed that, in the present favourite method of manuring with bones dissolved in sulphuric acid, we make provision for the three first substances. Recent bones contain, in round numbers, half their weight of phosphate of lime, which phosphate of lime consists of nearly equal weights of phosphoric acid and lime. Bones, then, contain one-fourth of their weight of phosphoric acid. To supply the 45 lbs. required by a crop of turnips we must not employ less than 2 cwt. of bones, leaving one-eighth of this quantity for loss. If the bones be dissolved in sulphuric acid (one-half their weight being employed), abundance of this latter substance will be introduced into the soil; and the lime of the bones, although not sufficient for the crop, will perhaps be an adequate addition, considering the prevalence of this earth in most cultivated soils.

But when bones and sulphuric acid are alone used, where is the plant to obtain its magnesia and its alkalies? Certainly not from the bones, for although soda and magnesia do exist in bones, it is in very small quantity. Following out our supposition of a barren soil, we must add about 2 cwt. of pearl-ash, three-quarters of a cwt. of Epsom salts, and (trusting to common salt to supply soda) 1 cwt. of common salt.

These are the quantities required for a crop of turnips. A crop of beet will require only half the bones and acid, the same quantity of pearl-ash as turnips, and twice as much common salt and Epsom salts. Twenty tons of carrots and their leaves will require the same quantity of bones and acid and pearl-ash, and twice as much Epsom salts and common salt as turnips.

Now, it is to be understood that we are speaking of the additions that must be made to soils having no available resources of their own. It is anything but our intention to recommend such methods as these, which would entail a considerable expense, and would in many cases be needless. We, however, think that sufficient attention has not been paid to the constitution of the manures used in the turnip culture.

It is to be remembered that a turnip-soil is not that which should supply the plant most freely with potash or soda, for these alkalies most abound in the stiff clays which are not suitable to the turnip; it is to no purpose that we feed a plant liberally with

one element necessary for its growth if it is denied another equally indispensable; and it may sometimes happen that the application of a smaller quantity of bones and sulphuric acid, accompanied by some alkaline body and magnesia, might, at the same expense, prove more effectual than the bones and acid alone, although in larger quantity.

Upon these grounds we would avail ourselves of the opportunity at present afforded us of inviting the members of this Society to make a trial of some such composition as the following:—

2 cwt. of bones (unburnt).
1 cwt. of sulphuric acid.
1 cwt. of pearl-ash.
$\frac{1}{2}$ cwt. of Epsom salts; and
3 cwt. of common salt.

The bones should be dissolved in the acid diluted with an equal bulk of water, and, after standing some hours, the pearl-ash, and Epsom salts, and common salt should be added.

This compound might be mixed with ashes, and drilled with the seed, or it might (previously mixed with ashes or dry soil) be applied as a top-dressing to the crop upon the appearance of the seed-leaf. It should be tried in the above proportion per acre, and in half that quantity.

We repeat this is only suggested for experiment.* It would appear wiser as a general rule to employ bones and sulphuric acid in connexion with a moderate application of farm-manure. Practice and theory are equally in favour of this plan.

The vegetable matter and ammoniacal salts of the manure force the plants rapidly into rough leaf, enabling it to defy its natural enemy—the fly; whilst the bones afford a lasting supply of nourishment, organic and inorganic, during the whole period of its growth.

Where farm-yard manure is employed there can be no deficiency of the alkalies and magnesia, and therefore no further necessity for their addition; and it is certain that a combination of the two classes of manures—a moderate dose of farm-yard dung with a moderate dose of bones and sulphuric acid—gives better results than a larger use of either alone.

It may be useful to recapitulate the principal points in the present report:—

Proportion of *bulb to top* in turnips very *variable.*

Autumn-planted turnips appear to have *much top.*

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* It might not be too late, even this season, to improve the crop of the later varieties by this manure. Any results so obtained would be very acceptable (no doubt) to the Agricultural Society. (Written June 19.)

Importance of producing an *early* and *full* development of the leaf.

Proportion of *water* in the bulbs and tops very *variable.*

Value of the crop influenced thereby.

Very *small* deviation in the per centage of *water* alters materially the value of the crop in *feeding* properties.

Ten tons of one crop *may* contain *as much solid food* as *twenty* tons of another.

Necessity of ascertaining *dry weight* of each crop in all comparative *experiments* on the growth of roots by *artificial manures.*

Artificial manures *may* sometimes increase the *weight* without increasing the *value,* the excess being *water.*

Correction easily made in such experiments.

Per centage of *mineral matter* in the bulbs and tops of turnips very *variable.*

But on the *whole plant* more *constant.*

A *given* quantity of mineral matter distributed *unequally* through the bulbs and tops.

This circumstance regulated by the *age* of the plants.

No mineral *distinction* between turnips, swedes and hybrids.

The variations in the quantity of ash due to the large proportion of *water.*

Greater diversity in composition in the ash of the top than in the bulb.

Soda appears to replace *potash* in the root-crops.

Chloride of potassium present in the *leaves* of the turnip, *not in the bulb.*

Quantity of *each* ingredient *more uniform* on the *whole crop* than in the *tops* or *bulbs.*

Experiments made upon the grounds of the *constancy* of composition must be made on the *whole plant.*

The ash in *mangold-wurzel* quite as *variable* as in *turnips.*

Large quantity of *common salt* both in *turnips* and beet—*more* in the *latter.*

More common salt in the *leaves* than in the *bulb.*

Beet and even turnips *given alone* may from the *common salt* be prejudicial to *lambing* ewes and *cows.* Removed by *steaming.*

Ash of the white Belgian *carrot* very similar to that of *turnips.*

Large crops of carrots raised *without manure* because of their *penetrating roots.*

Might be a better *fallow crop* than turnips.

Jerusalem artichokes contain *much* phosphoric acid and alkalies; and yet grow on *poor* soil without manure.

Beans and peas contain *little silica,* either in the grain or *straw.*

The mineral matter of the *grain* of beans and peas almost *identical.*

Very little *phosphoric acid* in the *straw* of beans or peas.

The *entire plant* of *peas* requires most *lime*, of beans most *potash.*

Beans should flourish on a stiff *clay*—peas on a *calcareous loam.*

Beans may with advantage precede or follow *wheat*, by *liberating* silica and *appropriating* potash.

Bones and sulphuric acid should not be used *alone* for turnips on *light* land.

Pearl-ash (or *wood* ashes) and Epsom salts might be *tried* with *bones and acid.*

Safest plan perhaps to use *artificial manures* in *conjunction* with *farm-yard manure* for root crops.

It has been represented to us, that it would be satisfactory to scientific men perusing the Journal, to know the methods of analysis employed; they are therefore here published as shortly as possible.*

Estimation of the water.—The grain of wheat, &c., entire—turnip bulbs and leaves, &c. cut up into small pieces, dried at about 150° or 160° Fahrenheit for a fortnight; weighed, dried again for another week or fortnight; drying completed in water bath (at 212°) till they ceased to lose weight.

Per centage of Ash.—100 or 200 grs. of wheat, barley, &c., from 60 to 80 grs. of dry turnip, &c., burnt in a small platinum dish (watch-glass shape) over air-flame of gas—burning continued with wheat, &c., till ash quite white. With ashes that fuse but yet contain little silica burning stopped before fusion begins; ash weighed treated with dilute hydrochloric acid; charcoal (seldom 1-10th of a grain) collected, washed, weighed, and deducted. In all specimens burnt for analysis, the estimation checked by the larger quantity.

Burning of the Ash for analysis.—4000 to 6000 grs. wheat, barley, carefully cleansed, &c., 1000 to 2000 grs. dry turnip, &c., burnt in large platinum dish over a Black's furnace, supported in the opening at the top by a solid iron ring; temperature never exceeding dull redness; perfect access of air; the dish being 8 or 9 inches broad, and 1½ inch deep only; ash stirred when necessary with thick platinum wire; burning discontinued so soon as the charcoal ceased to glow at a dull red heat; ash examined in case of any trace of foreign matter having been overlooked, powdered, dried, and weighed.

Analysis of the ash.—15 to 25 grains of ash heated with water and small quantity of nitric acid, filtered, precipitated by nitrate of silver

* The above description will be of no value to any one not perfectly conversant with such subjects. We have been unwilling to cumber the pages of the Journal with such matter, but it is a requirement of scientific investigation which is never dispensed with. Want of time alone prevented its introduction in the first report.

for chlorine; the excess of silver removed by hydrochloric acid; sulphuric acid thrown down by chloride of barium.

15 or 20 grains analysed for carbonic acid in the usual apparatus.

If the ash be silicious, or contain much charcoal—40 or 50 grains of ash mixed with its own weight of finely powdered pure and dry nitrate of barytes; mixture thrown by platinum-knife by small portions into large platinum crucible gently heated by a spirit-lamp; gentle deflagration occurs without loss; ash becomes quite white, and easily decomposed by acids; treated with hydrochloric acid, evaporated to dryness, the silica separated as usual. Correction made for sulphate of barytes present; silica dissolved by boiling for half an hour with caustic potash, filtered; loss of weight ascertained. Silica again separated by acid and evaporation. A certain measure of the liquid precipitated successively by caustic, barytes, and carbonate of ammonia, with caustic ammonia—evaporated to dryness, residue ignited, weighed, dissolved in little water and treated with chloride of platinum and liquid evaporated to dryness in water-bath; alcohol (containing a little ether) added; salt collected, washed with same liquid—dried at 212°.

The remainder of the liquid precipitated by slight excess of dilute sulphuric acid; sulphate of barytes collected and weighed; it always contains some sulphate of lime, which admits of calculation from the quantity of nitrate of barytes employed. One portion of the filtered liquid nearly neutralized by ammonia—acetate of ammonia added—warmed, and the phosphate of iron collected. Lime precipitated by neutral oxalate of ammonia; magnesia by phosphate of soda and ammonia; to the lime is to be added that present in the sulphate of barytes.

A second portion of the liquid filtered from the sulphate of barytes nearly neutralized by ammonia; acetate of ammonia and free acetic acid added; a solution of perchloride of iron of known strength added from a delicate alkalimeter till the liquid is decidedly red—boiled till the precipitate has separated, filtered; ammonia added to the filtered liquid will throw down phosphate of lime if phosphoric acid has escaped (in which case more iron must be added), or peroxide of iron with a little phosphate of iron, if iron has come through. This latter, which is always small in quantity, must be collected on a separate filter; but neither occurrence need be feared, if there be not too great an excess of iron, if plenty of acetate of ammonia is used and the solution be well boiled. The peroxide of iron present in the ash, and that added, being deducted from the whole weight of the precipitate, the phosphoric acid is the remainder.

With ashes containing but little silica or charcoal the same method adopted, but without deflagration by nitrate of barytes.

(This method of burning and of analyzing the ash gives accurate results. We have made a series of experiments upon the liability to loss either in burning or in the subsequent analysis, and the results are perfectly satisfactory—they will shortly be published through some chemical medium.)

IX.—*On the Cultivation of Field-beet (Mangold-wurzel).*
By George Edmund Raynbird.

Prize Essay.

The farmers of Scotland and the north of England are proverbially famous for the superior management of the turnip crop; they often astonish their brethren who reside in the dry southern or eastern counties with reports of crops, the weight of which it would be vain for those to attempt to equal who live in a less favourable climate for the luxuriant growth of the turnip crop. The turnip, whether swede, white, or hybrid, succeeds best in a humid climate, and hence some of the superiority of our northern brethren; but though we are obliged to confess that we cannot equal them in turnip cultivation, yet in the cultivation of beet the farmers of the south, particularly those of the eastern counties, will challenge competition with not only the north, but with the whole of England. Beet, unlike the turnip, grows to the greatest perfection where the climate is dry and warm, and therefore we must not attribute all the merit of our large crops to superior management, but rather to the genial climate, which is so favourable to this root.

A wild and worthless variety of beet grows naturally on the sandy shores of the sea; and it is found that beet flourishes with luxuriance in the country closely adjoining the coast.

Having thus briefly considered the climate most favourable to the growth of the subject of our inquiries, we shall proceed to describe—

1. *The Soils best adapted for Beet.*

It will be found, like most other plants, to produce the greatest bulk on a rich loamy soil that is neither too retentive nor too loose in its texture; it is not, however, at all peculiar to a particular soil. It will flourish on retentive clays that are unsuited to the growth of the turnip, better than it does on very light siliceous soils that are more favourable to the turnip and carrot. On peaty land, it is grown with much better chances of a good crop than the turnip; and it succeeds pretty well on stonebrash.

The soils which may be considered adapted for beet are—

1. Rich loam.
2. Clayey loam.
3. Loamy sands and gravels, or mixed soils.
4. Good peat or alluvial soil.
5. Sandy soils in the neighbourhood of the sea.
6. Calcareous soils that do not contain too great a proportion of lime;

And stonebrash that has a good depth of soil—say six or eight inches above the rock.

7. Fresh broken-up pasture of almost any description, excepting down or very light land.

Those which are not suited for the growth of beet are—

1. Light sands and gravels.
2. Chalk.
3. Very stiff clay.

2. *The preparation of the Land for Beet.*

3. *Manuring.*

4. *Time and mode of sowing.*

Like other roots, mangold-wurzel succeeds best with deep cultivation, and where it can be practised, the subsoil-plough should be used, but there is land which cannot be subsoiled, and yet produces excellent crops: for instance, the land drained with shallow earth-drains, as in Essex, Hertfordshire, Cambridgeshire, and Suffolk, the drains would be injured by the double ploughing, and hence on these soils a deep ploughing can only be given. On the stonebrash soils, subsoiling cannot be practised with much effect, as the share comes in contact with the hard rock; in all probability, there is not much benefit derived from breaking up the rocky subsoil too much at once, as roots of plants readily find a way through the many interstices that occur in the shattered subsoil. The peat soils are generally of so light a texture that no advantage could be expected from subsoiling, as it would give a still looser texture, which it ought to be the endeavour of the farmer to consolidate. On land with a retentive subsoil, and where deep draining is practised, subsoiling will be useful, as affording a greater depth of soil for the roots to derive food from, which, if not broken through, would in all probability hinder their downward progress. On gravelly and sandy land the deep ploughing will give a greater depth of soil, the advantage of which will be, that the roots will strike in deeper in search of nutriment, and consequently will be further from the surface, and less liable to feel the effects of drought; for it is a well-known fact, that a deeply-pulverised soil retains and attracts moisture during dry weather much better than a solid unbroken soil. As a general rule, beet is grown as a fallow crop after wheat or oats, and followed by barley or wheat.

We shall first consider the preparation of light land that does not require draining for beet; not that we consider that this description of soil is more favourable to its growth than any other, for it is on rich loams and clays that beet is of such peculiar value

to the farmer, from its early removal from the soil. On whatever soil, we would recommend the practice of mowing, bagging, or reaping very low the wheat that grows on the land intended for beet; for, by adopting the practice of cutting low, we take time by the forelock. The preparation of the land may begin immediately the wheat shocks are removed, instead of having to wait for the slow process of mowing and raking the stubble, which is often left in such quantities. The early period in the spring at which the seed requires to be planted, demands an early preparation of the land in the previous autumn. If we delay the process of cleaning the land for a week or two after harvest has been completed, we may perhaps be obliged, from unfavourable weather, to put it off till the spring, and then in all probability the land will work unfavourably, and the sowing be deferred altogether, and turnips take the place of beet, or the seed will be planted on land part cloddy, and the other part held together by couch-grass. If the stubble is very clean, it will merely require common ploughing, and the early cultivation will be less important; but when the land is overrun with couch and other weeds, which is too frequently the case after the wheat crop, the cleaning should commence as soon after the wheat is off as possible: this is effected by breaking up the land with the skeleton-plough, or scarifier, the land harrowed and rolled, and then scarified, across the first time; or the skim-ploughing, the rolling, and harrowing is repeated, and the rubbish collected by the harrows in rows is removed from the land: if the land works very fine, and the quantity of weeds considerable, they will be most effectually removed by hand-raking, and afterwards picking up the small pieces of couch. As soon as the rubbish is all removed, and the weather and other more important operations will allow—this may be about Christmas—the land is ploughed in 3-rod lands, a subsoil plough following the common plough, stirring the soil from 12 to 16 inches in depth. The subsoil-plough is drawn by 3 horses, yoked to a steelyard whippletree: the horses in the common plough walk on the land, and not in the furrow which has been stirred by the subsoil-plough. The furrows of the land are ploughed with horses at length in both ploughs, so that the trampling of the horses on the fresh ploughed land is prevented: in this manner the land lies light and pulverised for the action of the weather during the winter, and requires no more preparation till the time approaches for ridging and planting the seed, when it will require nothing further than a slight scarifying, and harrowing and rolling. When from some cause or other the land cannot be ploughed till the spring, the subsoiling is perhaps best left out; as it gives a looseness and hollowness to the soil, which requires in some measure to be rectified by exposure to the ele-

ments. The land is therefore common-ploughed to a sufficient depth in seasonable weather, and harrowed and rolled immediately after the plough, so as to give a fine surface before the land has time to harden into clods: this is repeated till a sufficient depth of mould is secured for ridging. Farm-yard manure is mostly applied for mangold, though a dressing of part dung and part artificial manure, such as guano, drilled in with the seed, is, frequently used, and is perhaps better than dung alone, though for mangold it is better to depend on farm-yard dung alone, than it is on artificial manure. Unprepared manure is very frequently used, though there is some difficulty in covering it in; it is, therefore, advisable that the dung should have some slight preparation. With this intention, it is removed from the yards during winter, and laid on a bottom of heavy soil in the field intended for beet, the carts being drawn across the heap to consolidate it, and by that means prevent loss from excessive fermentation: a short time before applying the manure to the land, it is well mixed by turning; so that at the time of carting it is so far advanced in decomposition, as to force the young plants into a rapid growth. The time for sowing is April and the beginning of May; the time varying, of course, with thê state of the weather and land. In commencing ridging and manuring, the following is the plan of operations—the great object being to cover the manure before it becomes wasted by evaporation, and to drill the seed before the land gets dry on the surface:—Three acres are ridged, manured, the manure covered in, the ridge rolled, and the seed drilled in, and then rolled again. To effect this, one man is employed drawing out the ridges at 27 inches, with a double mould-board plough drawn by a pair of horses; and another man with a similar plough splitting the ridges to cover the manure. About 14 two-horse loads of dung are applied per acre; and to manure 3 acres, it will require 3 carts and 5 horses, the manure heap being conveniently placed in the field—viz. 1 cart filling at hill, 1 cart going and returning to the hill, and 1 unloading; 3 men filling manure, 2 boys driving, 2 men throwing off the manure from the cart, and 4 or 5 women or boys spreading the dung in the ridges. The manure is spread by the 2 men, one standing on each side of the cart over 5 ridges, or rather 5 furrows, the horses being kept at a slow walking pace, by a boy who rides the shaft-horse. As soon as spread from the cart, the boys and women divide and shake the manure with forks evenly at the bottom of the furrows, and the plough follows closely upon them to cover in the dung before the gaseous parts fly off altogether, and the liquid becomes wasted by evaporation. After the ridges have lain exposed to the air a short time, they are rolled with a light roller, and the seed drilled, from 4 to 5 lbs., according to its

quality, with a one-horse drill (which sows 3 acres in about 2 hours), the coulters of which have universal joints, so that they will admit of both lateral and perpendicular motion; the coulters, three in number, being fitted with handles, are steered by a man and a boy. By this means the drills are kept exactly on the top of the ridge (which would not be the case if the coulters were fixed), and at equal distance from each other. This is important, because the horse-hoe has to work between the rows. The depth at which the seed is deposited is thus regulated with great exactness, for the person steering has nothing to do but elevate or depress his hand as the soil varies in solidity, and by that means secure a uniform depth, which is essential in sowing beet, because, if planted very deep, the seed does not vegetate, and, if very shallow, it does not grow if dry weather follow: as a general rule, we drill beet-seed rather deeper than swedes. The light roller is again used after the drill. The whole of the manure (with the exception of about five ridges for the plough to begin on next morning) being ploughed, and the seed drilled on all the finished ridges, will complete the day's work. When artificial manure is used in addition to the dung, it is either spread by hand on the dung in the ridges, or a manure-drill is employed, but the spreading by hand is to be preferred.

Subsoiling will also in some measure apply to deep-drained retentive soils, but on all close and adhesive soils, injury is done by spring-ploughing, for at that season of the year the land either ploughs up in clods, or adheres to the plough; the autumn-ploughing and manuring is therefore to be recommended. This is beginning to be adopted by some farmers in the eastern counties. The land is ploughed up as soon as possible after harvest, and between that time and Christmas it is ploughed into ridges about thirty inches in width (two ridges are covered by the cart wheels), the common single-breasted plough being used; the land is now manured with from 14 to 20 loads ($1\frac{1}{2}$ cubic yard) of farm-yard dung; this is covered in by splitting the ridges; nothing more is done in the way of preparation, for nature effects more in the pulverization of the soil, by the alternate frosts and thaws of winter, so as to afford a fine surface for the vegetation of the seed, than can be produced by the artificial means of ploughing and harrowing: by ploughing a retentive soil early in the spring, we plough down that fine surface-mould produced by the weather, which is so essential to the securing a good plant, and bring up in return a mass of clods, which frequently defy our utmost endeavours to pulverize: the carting farm-yard dung on heavy land during the spring is also injurious from the treading of the horses and cutting of the wheels: during the autumn and winter, dry and frosty weather can be chosen for manure-carting.

Two contrary systems of management are thus advocated on different soils. On light land, the manure being applied immediately before the seed is sown, is attended with great advantage; on heavy and retentive land this system cannot be adopted with any certainty, on account of the difficulty attending the cultivation of the land. It may be alleged that it is a waste of manure to cover it in the soil some months previously to the sowing of the seed. There is some truth in this remark, but it is only applicable to light lands, in which manure decomposes rapidly, and where there is no difficulty in obtaining a fine and garden-like surface; but the main point in the cultivation of roots on a heavy soil is a pulverized seed-bed. If weeds spring up on the land that has been ridged and manured during the winter, they may be destroyed by harrowing or scarifying, taking care not to go deep enough to bring the manure on the surface. If considered necessary, a light double mould-board plough drawn between the ridges will restore them to their former shape: and they will be ready for rolling down with a light roller, either for drilling or dibbling the seed.

We have mentioned only the ridge preparation; but the system of autumn preparation and manuring is equally applicable to drilling on the stetch or flat. Many beet growers, who pursue the practice of ploughing-in the manure in the spring, prefer growing on the flat, as they are more likely to secure a plant on a cloddy flat surface than they are on a ridge of clods; the manure is also more equally distributed over the land than on the ridge, consequently the following crop will derive an equal benefit from it. The latter is not much drawback to the ridge system, as the manure will be mixed by ploughing across the ridges for the succeeding crop. We have mentioned the manner of sowing beet on light or mixed soil, and this will refer also to strong land. Though generally in this neighbourhood dibbling is practised on strong land, this is done with the common iron dibble, with which a man, with a boy dropping, will do an acre in a day. Farmers in various parts of the country use a single or double wheel, with dibs fixed on the circumference, and others a flat frame of wood, with a number of dibs; but, though these methods facilitate the operation, yet they are all deficient in the twist of the wrist given by the man with his dibbling iron, by which the hole is prevented from filling up directly it is made.* Many recommend steeping the seed before it is planted; but perhaps the only case in which it can be adopted with propriety, is when circumstances prevent the seed being sown at a seasonable time, as the growth of the

* By using a drop-drill, or a larger dibber for making the holes, artificial manure may be deposited economically beneath the seed.

seed may be forwarded a few days by steeping, especially if rain follows the planting; but if seed which has partially vegetated be sown in dry soil, or dry weather follows the sowing, the chances are that the vegetation, which has been artificially commenced in the seed, will be destroyed altogether. Another great objection to the use of steeped seed is, that it cannot be delivered from the drill with any regularity unless it is first dried, which will impair the germination which has commenced.

The following is but a garden experiment, and therefore very little dependence is to be placed upon it, though it was made with a view of testing the practice of steeping on the vegetation of seed:—

Red mangold seed planted April 22, 1845, each quantity at an inch deep.

	April 30th.
30 seeds, steeped in Campbell's steep for 64 hours	3 plants up.
30 seeds, for 14 hours in a solution of nitrate of soda	5 do.
30 seeds, for 14 hours in water . . .	6 do. forwardest.
30 dry seeds	10 do up.

In favourable weather mangold seed will make its appearance above ground in 8 or 10 days. A small quantity of swede seed is sometimes drilled along with, or directly after the mangold seed: this is done to fill up any blanks that may occur. But the swedes generally take the lead; and, by their growing more rapidly, prevent the young plants of beet being seen by the man who hoes the crop. This may be partially obviated when the seed is dibbled, by dibbling the mangold at intervals of about 14 inches, and the swedes between the mangold seed.

Farmers who imagine that the removal of the whole crop of beet is injurious to the land leave one-fourth of the ridges to be planted with turnips, to be fed off with the leaves of the beet after the roots have been carted off. This may be practised with advantage on light soil suitable for folding sheep; though on stiff land that is injured by folding, we would recommend the land to be planted only with mangold seed, as that will be the most likely means of securing a crop; and should blanks occur, the best plan of filling these up will be after the first hoeing, with transplanted swedes, cabbages, or with beet, though the latter, when transplanted, run much to top, and seldom grow to a large size. Swedes transplanted in wet weather never fail of growing to a good size. As soon as the mangold are well up, the horse-hoe, skim, or common plough with a broad share drawn by one horse, is used between the rows. Three acres can be done in a day, at a cost of about 1*s.* 6*d.* per acre.

After this the plants are set out with the hoe, the distance varying from 14 to 18 inches, according to the richness of the

soil; the ridges are well pulled down by the hoe; women and children carefully look over the plants, singling all those left double, taking care to remove the weakest.

The horse-hoeing is repeated, and, when necessary, deep hand-hoeing is given, cutting up all the weeds, and pulling the soil away from the roots. The latter is particularly necessary on strong soils, as it prevents the beet growing with too many fangs or roots, to which beet is very liable on this description of land, particularly if cultivated on the flat. Another hand-hoeing is sometimes necessary, and horse-hoeing may go on till the mangold becomes too large for the passage of the horse-implement; for in proportion to the pulverization of the soil will the growth of the crop be increased, and as much benefit be derived from the production of a valuable crop as though the land lay entirely fallow.

The following was the management for beet on a piece of freshly broken up pasture. This was a very poor rushy pasture, of little value, on a subsoil of sand, gravel, and clay: land broken up in 1843, pared and burnt, the ashes spread, and land ploughed for oats; 1844, land ploughed and peas planted; after this crop had been harvested the land was ploughed up, and sown with mustard and rape fed off; 1845, about 5*l.* spent in draining, and land ploughed for oats; 1846, land clayed during winter, 40 cubic yards per acre, at 8½*d.*—1*l.* 8*s.* 4*d.* During dry weather the clay was harrowed and clod-rolled, in order to pulverize it before ploughing in. May 6th to 9th, ploughing the land very fleet, so that the clay was not covered in much. May 13th, clod-rolled and harrowed, and then began ploughing the furrows back, the ploughs going deeper than before, thus mixing the pulverized clay with the surface soil; land harrowed and light rolled after the ploughs. May 20th to 22nd, ridging and drilling yellow globe-beet, manured with 12 two-horse loads of unfermented dung per acre, and 1¾ cwt. per acre of Peruvian guano, sown in the ridges before splitting. June 2nd, mangold coming up, though, from the dry weather, they made their appearance very irregularly. June 20th, hoeing up weeds on the ridges; 22nd to 30th, horse-hoeing; 25th, showery weather, transplanting mangold to fill up vacancies. July 10th to 24th, horse-hoeing second time. July 28th to August 4th, hand-hoeing second time. November 2nd to 12th, pulling and stripping leaves, carting off with one-horse carts, and storing in adjoining field, the beet being laid in a triangular heap, 6 feet wide at bottom and 4 feet high, thatched with straw (4½ waggon-loads), and then covered with earth. Produce of 7 acres 1 rood, 252 cart-loads (about ¾ of a ton each). The whole crop was 189 tons, or about 26 tons per acre.

The following is the cost of taking up and storing:—

	s.	d.		£	s.	d.
Pulling and stripping the leaves off $7\frac{1}{4}$ acres, at	6	0	per acre	2	3	6
Filling into carts	2	6	,,	0	18	$1\frac{1}{2}$
Driving away	0	6	,,	0	3	$7\frac{1}{2}$
Stacking roots in heap	2	0	,,	0	14	6
Thatching	1	4	,,	0	9	8
Banking up	4	0	,,	1	9	0
Carting with 3 horses 4 days . .	4	0	,,	1	9	0
Carting and loading straw . . .	0	6	,,	0	3	$7\frac{1}{2}$
Total cost .				7	11	$0\frac{1}{2}$

Cost of taking up and storing per acre . . .	£1	0	10
Cost per ton about	0	0	$9\frac{1}{2}$

Cost of crop per acre.

	£	s.	d.
Claying, draining (permanent improvements), rent, &c. .	2	0	0
Two ploughings	0	14	0
Two harrowings	0	1	6
Clod-rolling	0	1	0
Rolling	0	0	6
Ridging	0	4	0
Drilling and rollings	0	1	3
Carting and spreading manure	0	8	0
Hand-hoeings	0	8	0
Horse-hoeing twice	0	4	0
Taking and storing the crop	1	0	10
12 loads farm-yard manure manure, at 5*s*. per load .	3	0	0
$1\frac{3}{4}$ cwt. guano	1	0	0
Total .	£9	3	1

Produce.

26 tons mangold, at 12*s*. a ton	15	12	0
200 sheep folding on tops 15 days, at 4*d*. per week (per acre)	0	19	$8\frac{1}{2}$
	£16	11	$8\frac{1}{2}$

5. *Varieties of Beet.*

The varieties of beet are very numerous, and doubtless numberless new varieties could be produced by hybridizing and other means. Those that are most generally cultivated for feeding cattle are the long red, the long yellow, the red and yellow globe, and the horn-beet, which is closely allied to the long red.

Experienced beet-growers agree that the globe-beet is better suited for light land, and that the yellow beet may be given to cattle earlier in the season than the red, without producing ill

effects. How far the latter is borne out by chemical observation we must leave scientific men to decide.

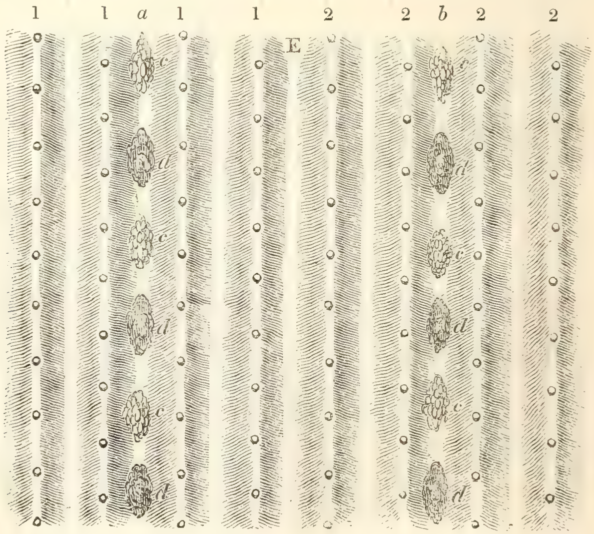
The sugar-beet is grown for cattle in some parts; but, as we have not had any experience in its cultivation, we decline to say anything respecting it.

6. *Mode and Expense of taking up the Crop.*

The usual time for storing beet is in October and November. The latter end of October is perhaps the best time, as the roots are liable to be injured by frost if they remain longer in the field; but the exact time cannot always be adhered to, as we must be ruled by the weather in our proceedings. Dry weather should always be chosen as the best season for storing the roots in good condition, and for their removal with the least injury to the soil. When the mangold is grown on ridges, the plan of operations is as follows:—From 4 to 6 men are employed pulling the mangold, and twisting the leaves off. The cost of this, when done by men, is from 5*s*. to 6*s*. per acre for an average crop, though in some places women and boys do this work for about 4*s*. per acre.

In order to do as little injury as possible in carting off the crop, the beet on four ridges, after they are pulled and the leaves stripped off, are laid in small heaps, the leaves being carefully laid in a heap.

The following diagram will perhaps illustrate this. The beet growing on the ridges 1, 1, 1, 1, are laid in the rows of heaps *a*; those on ridges 2, 2, 2, 2, on the row of heaps *b*; the roots in the



heaps *c, c,* &c.; and the leaves in the heaps *d, d,* &c. In carting off, the horsewalks in the furrow E, the wheels covering two ridges, and the two rows of roots *a, b,* are thrown into the cart. In this manner the work proceeds expeditiously, and with as little injury to the land by trampling as possible. The carts should always be driven up and down the ridges, and not across them, whether going with a load or returning empty; because, by adhering to this system, comparatively small injury will be done to the roots by carting over them, or to the soil by trampling. The utility of laying the leaves in heaps may be questioned by some, but a great deal may be said in favour of the practice.

The leaves, when intended to be fed either by sheep folded on the land, or carted off and thrown out on pastures for cattle or sheep, are always clean and fit food for cattle, which they are not when thrown over the land and trampled on. Besides this, the beet which has been pulled, and not carted during the day, should always be covered the last thing before leaving for the night, and the leaves, being laid conveniently in heaps, are used for that purpose. Mangold standing in the ground, and protected by the broad leaves, will stand a frost (if not very severe) without injury, but a very slight frost will damage those roots that are pulled; therefore it is a wise precaution to cover up those roots that are left at night. One-horse carts are the most convenient for carting the crop, as will be easily discovered by those who assist in harvesting beet. We find that when the heap to which the roots are carted is in the same field or field adjoining, that as many tons of beet may be removed with three one-horse carts as with three carts with five horses, and that with much less detriment to the roots and land. With carts drawn by two horses there is a loss of time in changing the trace-horse, and he is continually doing damage to the roots, and to the soil when wet. This is not a mere theoretical observation, but it is an opinion confirmed by having for many years taken part in the beet harvest.

The following company of labourers may be kept at work in storing a crop of beet, and with this arrangement the work will proceed so that all will have equal employment; and no loss of time will be occasioned by changing from one job to another. Three horses will be sufficient if the mangold are stored in the field; but if carted to a distance, the number of horses and carts must be increased in proportion to that distance:—

6 men pulling mangold and stripping leaves.
4 boys filling into carts.
1 boy driving.
2 men stacking roots.
1 man and a boy thatching.

With this company upwards of 2 acres, or from 50 to 60 tons of roots, may be carried in a day.

A crop of beet of about 20 tons per acre (not including top) will cost to take up and store on an average—

Day wages being 10*s*. per week.	*s.*	*d.*		£	*s.*	*d.*
Pulling and stripping leaves .	4	0	to	0	6	0
Filling into carts . . .	2	0	„	0	2	6
Driving (boys) . . .	0	6	„	0	0	8
Stacking roots in heaps .	1	10	„	0	2	0
Thatching with straw . .	1	0	„	0	1	4
Earthing up . . .	3	6	„	0	4	0
Manual labour .	12	10	„	0	16	6
Horse labour at 2*s*. 6*d*. per day	3	0	„	0	4	0
Carting and loading straw .	0	6	„	0	0	6
Total . .	16	4	„	£1	1	0

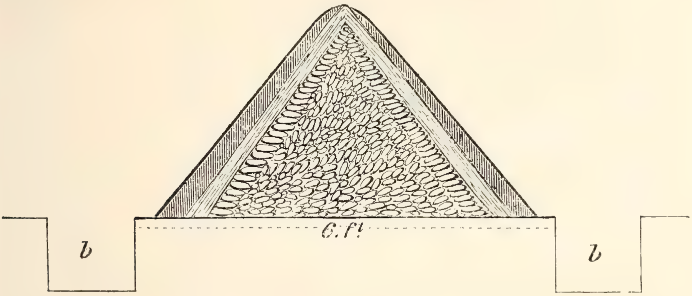
Or from 9*d*. to 12*d*. a ton.

A bad crop will cost considerably more per ton to take up and store than a good crop. If the roots are carted some distance and stored where they are to be consumed, the cost will of course be increased by the additional horse-labour required. When intended for feeding cattle, it is perhaps the best plan to store the roots as conveniently as possible for the cattle-sheds. In a wet season the removal of a crop of beet from a retentive soil is frequently injurious by the necessary treading in carrying the crop: in extreme cases this may be entirely obviated by removing the crop by manual labour; and though the soil in our immediate neighbourhood is not of that retentive nature, yet those who farm wet land have occasionally recourse to the carrying the crop to heaps at the side of the field in baskets or wheeling in barrows; and find that the cost does not greatly exceed the carrying the crop with carts. Planks to wheel upon would facilitate the operation.

7. *Mode of Storing.*

The plan of storing, almost universally adopted in this part of the country, is that of laying the roots in a heap on a headland, or side of a field, and covering first with straw or stubble, and then with earth. The best size for a heap is about 6 feet wide and 4 feet high. The annexed diagram shows a section of the heap. The loads of mangold are backed close against the heap and then kicked up, what remain in the cart are thrown out by a boy; and two men stand on each side of the hinder part of the cart, and stack the roots in a regular manner at the outside of the heap (as shown in the drawing). In this manner the heap is made till the whole crop is laid up. We generally have a heap from 30 to

35 perches long. As the heap is made it is thatched with straw about 1 foot in thickness, and in a few days mould from the trenches *b b* is dug and placed over the heap, leaving the straw exposed on the top of the ridge; to prevent heating, some place faggots to serve as chimneys or ventilators; but these are not required if the ridge be left open.



The trenches *b b* keep the bottom of the heap dry, and are filled up when the moulds are thrown off. Some farmers take the precaution of throwing another coat of straw or haulm over the earth; but this is not necessary if the first layer of straw is moderately thick. Mangold are best stored as dry and clean as possible, and to remove the soil from the roots they are gently knocked together by the persons who fill the carts; but if laid up wet and preserved from the frost there is no fear of their not keeping sound through the winter. The greatest danger is in the spring, when the roots will sometimes grow and heat, and rapidly become rotten. To prevent this the mould should be removed entirely from the heap in the spring when it is no longer required to keep out the frost: this will prevent heating, and the roots will keep sound through the summer. Some look the heap over, picking out the decayed roots (if any), and rubbing off the shoots, and then cover up again, or remove to a barn or outhouse.

There are many other modes of storing beet which answer the purpose very well, but we question if there is any practice so advantageous for a large quantity as that described above. To cover two or three hundred tons of beet with straw only, laid on sufficiently thick to keep out the frost, would require an immense quantity of straw. Some of the other methods are to lay the beet against a wall, and then thatch with straw; or to stack the beet within hurdles and cover with straw. The hurdles are double and stuffed with straw.

On stiff land mangold leaves are best ploughed in for manure, but on land benefited by folding they are certainly best fed off

with sheep on the land; mangold leaves from their succulent texture have a purging effect on sheep if given alone; but as before said, if swedes are transplanted to fill up the vacancies in the crop, and then fed off with the mangold leaves, they will act as a corrective; of course chaff or hay should be given in addition. Barley or wheat follows the beet crop; the latter is to be preferred in a favourable season, and it will be found that if the quantity should not quite equal that grown after clover, yet the quality of the grain will be above the average.

8. *The description of Stock to the use of which Beet is usually applied, and the advantages of the use of Beet as compared with other Roots, at the particular time at which it is so applied.*

The great advantage of beet over other roots, is the ease with which it may be kept in a sound state through the winter and spring, and, if required, through the summer, and hence its value for spring food; no other root grown for feeding cattle is found to equal mangold-wurzel in keeping sound after it has been removed from the land; the carrot will keep well till late in the spring, but it is a difficult crop to cultivate on stiff soils that produce heavy crops of beet. Turnips and swedes, though inferior to beet in storing, are yet superior to it for the purposes of feeding cattle during autumn and winter, and for folding with sheep; for the latter purpose beet will never be extensively used, from its inability to withstand frost, and from its requiring to be kept some time before it is suitable food: for even when stored on the land in small heaps, which is sometimes done, and then fed off, it must drive the barley-sowing too late in the season.

Mangold has the advantage over the turnip in its freedom from disease or injury from vermin in its young state: it is suited to strong land on which the turnip will not succeed; and also from its being off the land earlier, which is of particular advantage on wet land; and last, though not least, it is greatly superior to the turnip for spring food.

Mangold-wurzel will supply food to cattle after the time that turnips and swedes have been consumed till the clover and grasses have arrived at maturity; and it may also be given with great advantage with green food during summer.

But the great object in the growth of beet, added to its easy cultivation, its abundant produce, and great fattening properties, is the supply of spring food either to fat cattle, milch cows, or sheep.

Beet is given to fat cattle after the white turnips and swedes are consumed; and when the cattle are getting forward in condition, a gradual change being made from one root to another. When given early in the season they will always be found to have a purg-

ing effect, and therefore if used at all should only be given in small quantities and in conjunction with dry food; thus from the early frost which has set in, we have been obliged to feed our cattle when first brought into the yards on beet; and to obviate the purging effect in some measure, the beet is cut small with a slicer, and then mixed in the troughs with straw-chaff; but unless it is from necessity beet should not be given early in the season.

The yellow varieties are used first, as these are found to be less loosening in their effects on animals.

The quantity of beet given in a day is about 3 bushels, varying with the size of the cattle, with an allowance of corn, cake, and chaff.

On a light land farm beet is of great use, when given in troughs, to fatting sheep, when first folded on grass or clover after the turnips are consumed; and they are also useful for the same purpose on adhesive land; but on this description of soil beet is best given to cattle or to sheep fed in yards or sheds. To breeding sheep a limited allowance may be of great benefit in March and April, either thrown out on a dry pasture or given in troughs. Given to cows they are found to produce an increased quantity of milk, which will amply repay an allowance of 1 bushel a cow per day; and for this purpose it is superior to the turnip or swede, though perhaps inferior to the carrot. The late Earl Spencer has proved that mangold is at least equal to swedes in its feeding qualities.

The following experiment is extracted from a pamphlet on mangold-wurzel, written by Thomas Newby of Cambridge, and published in 1828, a book which has, perhaps, had but a local circulation:—

"On the morning of the 18th of October two milch cows which had calved in the spring were selected and turned out into an over-eaten pasture, and fed every morning and evening with hay only—the milk was measured at each meal, the cream was also measured, and the butter weighed at each churning; and the result was as follows for one week:—

Milk	. .	101 quarts.
Cream	. .	$5\frac{1}{2}$,,
Butter	. .	$4\frac{1}{2}$ lbs.

The cows remained in the same pasture another week, and were fed with mangold-wurzel and hay, each cow having half a bushel of the root sliced, and given to them morning and evening; the result was—

Milk	. .	130 quarts.
Cream	. .	$8\frac{1}{2}$,,
Butter	. .	$6\frac{3}{4}$ lbs.

The cows remained in the same pasture one week more, and were fed

every morning and evening with hay only, as first mentioned, and the experiment produced only—

Milk	. .	87 quarts.
Cream	. .	$4\frac{3}{4}$ „
Butter	. .	$3\frac{1}{2}$ lbs."

Mr. Newby's work is, in all probability, the most voluminous report on the cultivation of beet yet written; it is a compilation from the reports of gentlemen in various parts of the country, to whom Mr. Newby supplied seed, of what was then considered the only genuine stock, the long red variety. He mentions that the mangold-wurzel was first introduced into this country for general use about the year 1786, by Thomas Boothby Parkins, Esq., then residing at Metz in France, who sent a packet of seed to the late Sir Richard Jebb, Bart.; and among the earliest cultivators of this root were Sir William Jerningham and Sir Mordaunt Martin, of the county of Norfolk. Mr. Newby introduced its cultivation into Cambridgeshire in 1812.

To save seed, the best-shaped roots should be selected at the time of storing the crop, and stored separately. About the beginning of April they may be dug in; the distance from each root being 2 to 3 feet. Care must be taken that the top of the roots are just under the soil, for if covered in very deep, it sometimes happens that the shoots will not make their way through the soil; and on the other hand, if the mangold protrudes far above the surface, it will shoot at first very well, but after a time will suffer if dry weather follow, and will be liable to be broken off by high winds.

The seed generally ripens in September, and may be cut and set up in shocks, and when perfectly ripe threshed in the field.

The seed will require a keeper, as birds are very fond of it; it may be preserved in sacks hung up, to keep the mice from it.

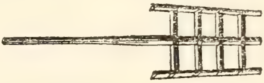
In concluding this report, I shall only remark, that much more might doubtless have been written on the subject; but I thought it best, and most conformable to the regulations of the Society, to confine myself either to what has been practised by my father during a space of twenty-seven years (in which time he has never failed in securing a crop), or to what I have myself seen practised by other farmers.

Hengrave, February 24th.

X.—*Turnip Manure.* By E. Wagstaffe.

Until 1844, I generally manured with 20 loads of farmyard dung and 8 bushels of bones per Scotch acre.

In 1844, instead of the 8 bushels of bones put in the drills on the dung, at sowing time, I did as follows:—As soon as I could get the dung into the field, in February or March, I calculated for every Scotch acre of land, 20 loads of dung, 63 lbs. of vitriol, and 126 lbs. of bones, either dust or mixed drill. Thus: I procured a few old treacle or oil casks, and put them by the side of the dung-heap,—put 189 lbs. (19 gallons) of water into one of the tubs, and to that 63 lbs. of vitriol;—to this mixture I put 126 lbs. of bones—one man (or two) to let in the bones very slowly out of a sack, another man stirring the contents, as the bones fall in, as fast as he can, with an implement like what they mash malt with in brewing.



Let this mixture stand two or three days, if a week so much the better; stir it every day. Then put water to it till you think you have as much as 20 loads of dung will contain, without its running away to waste. Turn the dung over into a well-shaped heap (or midden), and when turning it, to every layer of turned dung, throw on this diluted liquid with cogs or pails. Shape up the midden neatly, and put on a good covering of earth all over it—rather more than the usual covering.

A little practice will show how many acres can be mixed for in each tub at one time, and before diluting this first mixture, a certain portion of it may be put into a separate tub to be diluted, remembering always to stir it well before lifting it into the separate tub, and also before throwing it on the dung.

The proportion of the first mixture to be, in weight, 3 waters, 1 vitriol, and 2 bones—whatever quantity you may wish to use to an acre. A gallon of water is about 10 lbs.

Comparative cost of the old way and new—

Old way, in 1845, 20 loads of dung at 3*s.* 6*d.* . . .				£3	10	0
8 bushels of bones, at 3*s.*				1	4	0
				£4	14	0
New way, same year, 20 loads of dung, at 3*s.* 6*d.*	£3	10	0			
126 lbs. of bones, viz., $2\frac{3}{4}$ bush., at 3*s.*	0	8	3			
63 lbs. of best vitriol, at 1*d.* 1-5th .	0	6	4			
				4	4	7
Saving per acre . . .				£0	9	5

and in every instance, in 1844, '5, and '6, my turnips have been declared by good judges to be a guinea an acre better by the new way than by the old; and the crops following the new process, particularly grass, have been earlier and better than those following the old. And in 1846 I was rather short of dung, and took off 5 loads of dung per Scotch acre, and added 104 lbs. ($2\frac{1}{4}$ bushels) of bones, and 52 lbs. of vitriol,—and with this change, which was an additional saving, the turnips maintained their superiority, over the old way, to the full extent.

The old way, as before stated, 20 loads of dung and 8 bushels of bones		£4 14 0
New way, in 1846, 15 loads of dung, at 3*s*. 6*d*.	£2 12 6	
230 lbs., or 5 bush. bones at 3*s*. .	0 15 0	
115 lbs. of vitriol, at 1*d*. 1-5th .	0 11 6	
		3 19 0
Saving per acre		£0 15 0

With regard to labour, I consider that the dung-heap has to be turned in the old process, and that carting the bones to the field and sowing them on the dung in the drills, at the hurried sowing season, is more than equal to mixing the vitriol and bone liquid, and throwing it on the dung-heap at an earlier and less hurried season.

Westerton, by Huntly, March 31, 1847.

XI.—*On Agricultural Chemistry.* By John Bennet Lawes.

It is a matter of surprise that so little is actually known upon the theory of agriculture. Its practice is nearly coeval with mankind, while as yet it scarcely exists as a science. Ask the most experienced farmer to explain the principles which govern the routine he is daily in the habit of practising? Ask him to determine the value of any rotation of crops, or their comparative exhausting powers? Ask him what ingredients must be restored to the soil to keep its fertility unimpaired? or the exact manner in which climate influences his produce? His answers will be vague and unsatisfactory. But these, and a thousand other questions of a similar nature, are capable of solution by science, and they must be answered before agriculture can be said to rest upon a satisfactory foundation.

Independently of the money which must annually be lost in fruitless experiments, the disadvantages attending the want of fixed rules in agriculture are many. Numbers of men possessing capital are deterred from farming by the proverbial uncertainty of the profits attending it; and many who follow the profession of agriculture,

and have the means, will not freely embark their money on the improvement of their farms, for want of that knowledge which would enable them to calculate their returns with any degree of certainty. Hence, too, the tenant farmer is frequently compelled to adopt a rotation of crops entirely prejudicial to his interest, retained only because it happened to be the custom of our ancestors a century ago, while the same rotation is enforced upon the farmer who expends 8*l*. an acre on his land, as upon him who expends only 3*l*.

Liebig's work on Agricultural Chemistry, published in the year 1840, attracted very generally the attention of British agriculturists. In those pages they were first made acquainted with the important aid they were likely to obtain from the science of chemistry applied to the cultivation of the soil. The work of Sir Humphry Davy upon the same subject can hardly be said to have influenced the practice of agriculture. He applied the knowledge of chemistry, as it then existed, with his usual sagacity, but at the period in which he wrote organic chemistry was quite in its infancy. The labours of the German and French chemists during the last thirty years have principally been directed to the study of organic chemistry, which owes its present important position to the number of accurate analyses they have given to the world. It is much to be regretted that Liebig should have altered, in the third edition of his work, so many of the views and opinions laid down in the first; or that a hasty visit to England, during which (as he says in his preface) he made himself acquainted with practical agriculture, should have caused him to pronounce as valueless the experiments of Boussingault, whose opinions are entitled to respect, as coming from one in whom are combined the scientific chemist and the practical farmer. Without entering into the merits of the different opinions maintained by these distinguished chemists, I may here observe that many of the errors into which Liebig has fallen, have, I think, arisen from his not sufficiently considering what agriculture really is. *Practical agriculture consists in the artificial accumulation of certain constituents to be employed either as food for man or other animals, upon a space of ground incapable of supporting them in its natural state.* This definition of agriculture is, I think, important, as distinguishing English agriculture at least from the system pursued in various parts of the world, where the population is small and the land of little value, viz. of taking only the natural produce of the soil, without any effort to increase it, and in time abandoning it for a soil as yet undisturbed. If Liebig had sufficiently considered this distinction, he would not have assumed that certain substances employed as manures are of little value, because plants and trees, in their natural state, are capable of

obtaining them in sufficient quantity for their use. The great problem to be solved with regard to manures is, what substances is it necessary to supply to the soil in order to maintain a remunerative fertility? The solution of this question appears easy enough, regard being had only to the composition of the crops removed. Practically there are, however, great difficulties attending it, which can only be entirely overcome by a long series of careful and costly experiments. If the ash theory advanced by Liebig, and so industriously propagated by his pupils, were founded on truth, a careful examination of the ashes of plants, and a few simple calculations upon the amount of mineral substances exported from the soil in corn, meat, &c., would at once enable us to explain and remedy the exhaustion of our soils. The farmer, when he sends his load of wheat to market, would bring back the few pounds of minerals which the wheat contained, and the return of these to the soil would enable him to produce the same amount of wheat for the market the following year. Unfortunately, however, the ground-work upon which this theory is raised is unsound, when agriculture, as distinguished from natural vegetation, forms the subject of consideration.

Agricultural plants, which practice has shown to differ widely from each other in their respective relations to soil, climate, manuring, and position in rotation, possess at the same time widely differing powers of reliance upon the atmosphere for the constituents which it is known to supply in a greater or less degree. If grain crops held the same relation to natural and artificial supply of their organic constituents, as the leguminous plants and turnips, the farmer would not require the assistance of the latter crops; but since, compared with these, the grain crops are in some important respects far more dependent upon artificial supply to the soil of certain organic constituents, of which the price is high and the supply limited, it becomes necessary to employ certain plants which possess the power of collecting these ingredients from the atmosphere, and such procedure constitutes a rotation of crops.

For some years past I have been engaged in a very extensive series of experiments upon my farm, with a view to determine some of the more important questions which are constantly arising in the minds of agriculturists. It would be impossible in a paper of this description to enter into a detail of the plan I have pursued in conducting these experiments. Keeping in mind the motto of the Society, '*Practice with science*,' I shall now merely select those results which bear most upon practical agriculture, and which appear to me most suitable to my present purpose. The greater portion of these experiments, and the various points of science connected with them, will be discussed with more pro-

priety in an independent work. The views which I have adopted, and which I shall now endeavour to explain, have arisen during the course of these experiments; but it is very probable I shall have reason to modify them as the investigation proceeds.

I certainly place great reliance on the experimental results which I possess; every operation has been conducted under the eye of Dr. Gilbert, a gentleman who received his scientific education in the best British and continental laboratories, and has applied that accuracy which modern science demands, both to the operations of the laboratory and the field.

In the first place I shall offer some general remarks upon the growth and nature of the common agricultural plants, and afterwards endeavour to show the effect of manures upon them.

The crops which form a rotation belong, botanically speaking, for the most part to the three following natural orders of plants:— The *Gramineæ,* containing wheat, barley, oats, rye, and the grasses which constitute our natural pastures; the *Leguminosæ,* containing beans, peas, tares, lucerne, clover, trefoil, saintfoil, &c.; and the *Cruciferæ,* containing turnips and rape. The *Solaneæ,* yielding the potato, and the *Umbelliferæ,* carrots and parsnips, may also be noticed. For the purposes of agriculture, however, a different system of classification might be adopted with advantage, having reference to the organ or part of the plant which is the object of cultivation. In clover, tares, and pasture, we generally require leaf and stem, which may be termed the primary organs of plants; in the turnip we require the bulb or intermediate organ; and in the grain crops, peas, beans, &c., the ultimate organ, the seed.

In considering this subject it is necessary to bear in mind that the natural aim of every plant is to produce a perfect seed, and that, when growing in a soil and climate adapted to its special habits and peculiarities, it produces no more of each organ than it requires for the healthy perpetuation and reproduction of seed. When the leaf has fulfilled its office, the nutritious fluids circulating through it are withdrawn, and it decays or dries up. These fluids enter into the stem, and, rising higher and higher, are at length deposited in the seed. Plants are therefore required by agriculturists in two distinct conditions, one in which the nourishment is more or less circulatory, the other in which it is fully elaborated and deposited: in one case water constitutes above three-fourths of the weight of the produce; in the other it does not generally amount to one-fifth. Although the agriculturist possesses the means of developing the circulatory or elaboratory conditions of plants by manures and mechanical operations, climate exerts the greatest influence over them. By climate I mean the quantity of rain that falls, the number of days on which

it falls, and the temperature during the period when the plant is actively growing or forming seed.

As the experiments to which I am about to refer were performed during the seasons of 1844, 5, and 6, I wish to make a few observations upon the climate of each season, and to show how the general condition of the crop was influenced by it. The temperature and fall of rain I have taken from the tables published by the Horticultural Society at Chiswick, from which my farm is little more than 20 miles distant, consequently the climate may be said to be nearly identical.

TABLE 1.

Number of days' Rain during 30 wks. and 4 days.				Inches of Rain during 30 weeks and 4 days.			
	1844	1845	1846		1844	1845	1846
April . . .	7	15	18	April . .	0·33	0·99	3·84
May . . .	7	21	10	May . . .	0·26	2·88	1·35
June . . .	10	8	2	June . . .	0·97	0·98	0·64
July . . .	10	21	16	July . . .	1·94	2·16	1·60
August . .	16	21	17	August . .	2·00	3·32	4·82
September . .	12	11	6	September .	1·27	1·68	1·39
October . .	19	13	24	October . .	4·19	1·48	5·50
	81	110	93		10·96	13·49	19·14

Mean Temperature during 30 weeks and 4 days.				Mean Temperature above or below average.			
	1844	1845	1846		1844	1845	1846
April . . .	51·1	48·3	47·0	April. . .	4 above	1·0 above	Average
May . . .	54·2	49·5	55·7	May. . .	½ below	1·8 above	3 above
June . . .	62·3	61·8	66·3	June. . .	2 above	0·9 below	6¼ above
July . . .	64·3	62·0	64·7	July . . .	1·6 above	0·9 below	2 above
August . .	60·4	58·9	65·2	August . .	2·2 below	4·6 below	2·7 above
September . .	60·0	55·2	62·5				
October . .	50·2	51·2	52·7				
	57·5	55·2	59·1				

The season of 1844 was remarkable for bad crops of hay, clover, late-sown barley, and oats, very fine wheat with very short straw, and average turnip crop. In 1845 there was abundance of hay and clover, bad quality of wheat, abundance of straw, and one of the largest crops of turnips ever known. In 1846 the grass and first crops of clover were unusually abundant, wheat was of very fine quality, straw moderate, turnips deficient. Of course, there are plenty of exceptions to what I have stated, and

these remarks do not apply to those places in which the climate varies much from that of London; but I have given what I believe to be the general character of the crops within a circle of 100 miles from London.

The soil upon which my experiments were tried consists of rather a heavy loam resting upon chalk, capable of producing good wheat when well manured, not sufficiently heavy for beans, but too heavy for good turnips or barley. The average produce of wheat in the neighbourhood is said to be less than 22 bushels per acre, wheat being grown once in five years. The rent varies from 20*s.* to 26*s.* per acre, tithe free. The fields selected for purposes of experiment had been reduced to the lowest state of fertility by removing a certain number of corn crops without applying any manure, and wheat and turnips were chosen for the subjects of investigation. The wheat-field consists of 14 acres, the crops removed since it was manured barley, peas, wheat, oats. In 1844, the first experimental wheat-crop was harvested, and the fourth is now growing. The turnip-field had not long been taken in hand, and was known to be in so poor a condition that it was at once put under experiment, and in 1843 the first crop of turnips was sown and they have been continued each year since, the produce being removed and weighed. The wheat-field was divided into a certain number of equal spaces, of which one has been left unmanured and one received 14 tons of dung every year; the remainder of the plots received different descriptions and quantities of artificial manures.

The following table gives the climate of the three years from the beginning of May till the end of October. I have considered the climate as affecting the grass to be that of April and May; wheat-climate to commence with May and end with August; turnip season to begin with June and end with October:—

It will be seen that the two spring months of 1844, April and May, were unusually dry; the quantity of rain and the number of days in which it fell were both small; the summer was hot and dry, and the autumn moderately rainy. An entire absence of the climate necessary for an enhanced accumulative and circulating condition of plants prevented the favourable growth of the spring crops, and a hot and dry summer favoured the depositing and elaborative condition, and produced good quality of grain. In 1845 the great number of wet days and the low temperature of the summer were highly favourable to a circulatory condition of the plant, consequently green crops of every description and straw were unusually abundant, and grain of bad quality. In 1846 the spring was very favourable to a circulating condition, producing luxuriant crops of grass and clover. The month of June, when the grain was forming seed, had a tempera-

TABLE 2.

	1844	1845	1846
No. of Days' Rain during April and May (Grass Season)	14	36	28
No. of Days' Rain from May to end of August—17 weeks (Grain Season)	43	71	45
No. of Days' Rain from June to end of October—21 weeks (Turnip Season)	67	74	65
Inches of Rain during April and May (Grass Season)	0·59	3·87	5·19
Inches of Rain from May to end of August—17 weeks (Grain Season)	5·17	9·34	8·41
Inches of Rain from June to end of October—21 weeks (Turnip Season)	10·37	9·62	13·95
Mean Temperature during April and May (Grass Season)	52·6	48·9	50·5
Mean Temperature from May to end of August—17 weeks (Grain Season)	60·3	58·2	63·1
Mean Temperature from June to end of October—21 weeks (Turnip Season)	59·4	57·8	62·2
Temperature above or below average from May to end of August (Grain Season)	above 0·9	below 2·1	above 3·2

ture $6\frac{1}{4}$° above the average, with only two days in which rain fell, and produced very fine quality of grain. The inferior crops of turnips obtained that year, notwithstanding the large total amount of rain, arose from the almost entire absence of rain for thirty-one successive days, twice during the season. From May 21st to June 21st no rain fell, and from August 22nd to September 21st there were only three days' rain, amounting to less than one-tenth of an inch.

The following table indicates the effect of climate upon the quantity and quality of the produce of the unmanured plots of the experimental wheat-field (during three seasons); the average results of the variously manured plots are also given:—

	1844.	1845.	1846.
Corn, per acre, in bushels, pecks, and quarters	16	23	. 17. 3. 3
Straw, per acre, in pounds	1120	2712	1513
Weight of corn, per bushel, in pounds	$58\frac{1}{2}$	$56\frac{1}{2}$	$63\frac{3}{4}$
Per centage of corn to straw (straw 1000)	821	534	797
Mean of all the plots—			
Weight of corn, per bushel, in pounds	$60\frac{3}{4}$	$56\frac{1}{2}$	63
Per centage of corn to straw (straw 1000)	868	499	765

The effect of the climate of these three seasons, as indicated in this table, is quite in accordance with the general character of

those seasons. The lowest weight of the bushel and the greatest amount of straw were obtained in that season which had the greatest number of rainy days and the lowest temperature; the least amount of straw with the driest season, and the finest quality of grain in the hottest summer. On comparing the proportion of grain to straw and the weight per bushel of the corn obtained from the unmanured space, with the average results of the various experiments, it will be seen how much they agree one with another, and this is the more remarkable as manures of the most varied kinds were employed, some of which doubled the natural production of the soil.

It is highly important that experiments should be tried in different parts of England, having reference to the effect of climate upon produce. A rain gauge and a register thermometer is all the apparatus required. If half an acre of the different crops on a farm were carefully weighed, and the relation of corn to straw, leaf to bulb, and the quality of grain estimated, we should in a few years be put in possession of sufficient data to enable us to speak with certainty upon this subject. It would then be seen that each shower of rain and each change of temperature had an effect upon vegetation, which, when once ascertained, might always be calculated on. The farmer would be able to make an estimate of the quality and produce of his crops before a grain had been removed from his field. Even with the information obtained by a careful examination of the above table, it is hardly to be doubted that the farmers in Scotland and in the north and west of England can produce turnips of finer quality and at less expense than those who dwell in the middle and south of England, and that the farmer in the south of England can produce the best corn. By the application of capital and skill an artificial climate may, to a certain extent, be obtained. I shall point out some of the means to be employed when speaking on the subject of manures. But where equal means are employed I think a farm upon which there are a certain number of rainy days in the summer and autumn possess advantages in the production of green crops over another farm upon which the average amount of rainy days is less; and, on the contrary, where the least number of rainy days and the highest temperature exist, corn of the best quality can be produced. The summer of 1846, with a mean temperature of more than three degrees above the average of the climate of England, having produced grain, weighing $63\frac{3}{4}$ per bushel, upon any soil from which seven unmanured corn crops had been removed, proves undoubtedly that high quality of grain to a great extent is determined by climate independently of the action of manures. We should, therefore, expect that those countries enjoying a hotter and drier summer than our own would

produce corn of superior quality, and such, indeed, is the case. In spite of the wretched system of agriculture which prevails in Spain, Russia, Poland, and Sicily, the quality of their corn will bear comparison with that which the skill and knowledge of the British agriculturist can secure. The climate of Australia combines in an eminent degree the small amount of rain and the high temperature necessary for the perfect development of corn, and the wheats imported from that island obtain a price in the market very much beyond those of English growth. The following table gives the average climate of Australia compared with that of London during the summer:—

	London.	Adelaide.
Number of days' rain in four months	60	19
" inches " "	8·49	3·88
Mean temperature " "	60·	79 F.

Although in producing good quality of corn the farmer labours under a disadvantage with regard to climate in England, its low temperature and moisture are exactly suited for our turnip crops, and the advantage which he derives from this plant more than counterbalances the inferior quality of his grain.

We now arrive at another important question—What is meant by quality of wheat? Does it depend upon the weight per bushel, or specific gravity of the grain? and if so, does this specific gravity bear any relation to the per-centage of gluten and albumen; that is to say, to the most highly nutritive constituents of the grain? Before entering into a consideration of this subject it may be as well to state the opinions generally held regarding it. The grain is composed of a variable proportion of protein compounds, gluten and albumen; and carbonaceous compounds, comprising starch, sugar, gum, oil, &c. The protein compounds are employed in the organism of man and other animals in forming flesh, while the carbonaceous compounds supply heat and form fat. The protein compounds being of much the greatest importance to the animal economy, it has been generally supposed that the value of different descriptions of wheat depends upon the amount of gluten and albumen which they contain; that the wheats of hot climates contain a greater proportion of these substances than our own; that for this reason the miller purchases them at a higher price; and that by employing rich manures the farmer is enabled to increase the per-centage of gluten in his corn. To the agriculturist it is of little importance that his wheat is rich in protein compounds, unless they increase its value in the market. Now millers, who are his principal

customers, know nothing about gluten and starch; they judge by the eye alone, and give the highest price for that which will yield the greatest proportion of flour. The following table demonstrates that the value of different samples of wheat does not depend upon the per centage of nitrogen which they contain.*

Nos.	Season.	General Remarks upon the History of the Specimens.	Per Centage of Nitrogen in Dry Matter.	Price per Qr. according to *present* rates adjudged by Miller and Corn Factor.
				s.
1	1844	Grown by Superphosphate of Lime . . .	3·03	84
2	,,	As No. 1, with Ammonia Salts	2·65	86
3	1846	Liebig's Patent Manure	1·81	96
4	,,	As No. 3, with Ammoniacal Salts . . .	1·69	92
5	,,	As No. 3, with Rape Cake	1·89	88
6	,,	As No. 3, with Rape Cake and Ammoniacal Salts.	1·88	..
7	,,	Exhausted Soil, Unmanured	1·95	92
8	,,	,, ,, with Ammoniacal Salts .	2·01	92
9	,,	,, ,, with Rape-cake. . . .	1·85	92
10	,,	,, ,, with Rape-cake and Ammoniacal Salts	1·93	92
11	,,	Australian, No. 1	..	112
12	,,	,, No. 2	1·94	112
13	,,	,, No. 3	2·38	112

From this table it is evident that the samples of wheat most approved by the miller are by no means those which are richest in nitrogen. His choice is directed to those samples which have the character of a perfectly developed grain, small, plump, and thin-skinned. But laying aside the evidence of experiment or common usage, would it not be more consonant with general principles to suppose that a class of plants proverbially characterized as yielding starchy seeds, and whose predominant peculiarity it is to produce carbonaceous substances, should, in their most perfect state of development, be rich in starch rather than in gluten and other nitrogenous compounds? We might, indeed, expect to find the proportion of gluten and starch vary in different species of wheat, and in the same species under the effect of different climates and seasons; but the more perfectly the grain has been developed the richer in starch and the poorer in nitrogen it would become, and millers who prefer a perfectly developed grain probably pay the highest price for that which contains the most starch.

* The wheat employed as seed in these experiments was the Old Red Lammas: nearly 2 bushels were drilled per acre. The crops of 1844 and 1846 were sown in September, and that of 1845 in March.

That the gluten and albumen in wheat would increase in proportion to the richness of the soil and to the amount of nitrogen and ammonia supplied in the manure seems so reasonable a supposition that its correctness is admitted without dispute; and various experiments have been tried which appear to favour this opinion. Boussingault, in his 'Rural Economy,' says, that wheat planted in an open field gave 2·29 per cent. of nitrogen, equivalent to 14·31 per cent. of gluten and albumen, while that planted in a rich garden-soil gave 3·51 of nitrogen, or 21·94 of gluten and albumen; and Hermstadt obtained from wheat grown—

In a soil unmanured . . .	9	per cent of gluten.
In a soil manured with cow-dung .	12	ditto.
,, sheep ditto .	22·9	ditto.
,, bullock's blood	35	ditto.
,, urine . .	36	ditto.

It is not stated how the gluten and albumen were determined, but it is not improbable that some mechanical process was employed; at all events, I have great doubts about the accuracy or the completeness of the experiments. Thirty-five per cent. of gluten would be equivalent to nearly 6 per cent. of nitrogen, a quantity certainly greater than wheat ever contains. My own experiments do not give the slightest indication of an increase of nitrogenous element of wheat grain by the employment of ammoniacal manures. That the average produce of nitrogen in the crop bears a certain relation to the ammonia supplied in the manure is very evident; but the per centage of nitrogen in the grain cannot be increased by means of it. In some experiments, the quantity of ammonia supplied by the manures was from 60 to 70 lbs. per acre, and in some instances more; but the analyses give no evidence of an increased per centage of nitrogen by its supply, and the highest amount obtained in the series was from an experiment where no ammonia was supplied in the manure. Dr. R. D. Thomson, in his "Experimental Researches on the Food of Animals," says, "It is a sufficiently remarkable fact, that oats increase in nutritive power in proportion to the increase of latitude within certain limits, while wheat follows an inverse law." He seems here to have adopted the prevailing opinion that the finest descriptions of wheat contain the most nourishment. The oat, which is capable of thriving in a moister and colder climate than either wheat or barley, would undoubtedly contain more nourishment when grown in high latitudes, simply because the climate is not favourable to the production of the important carbonaceous compound of gramineous seeds, starch. But with the most favourable condition of soil and climate the grain-producing plants are undoubtedly governed by one and the same law. Al-

though I have not at present traced the changes which take place during the growth of wheat, it appears to me that when sown in a soil containing abundance of azotized matter it employs this substance at first in extending its leaf, and that where an excess of ammonia is supplied the production of leaf is increased to an extent greatly injurious to the next operation of the plant, which is to produce stem. If an excess of ammonia is added late in the spring the plant will no longer increase in leaf, but in stem or straw, which also may be increased to an injurious extent. When the azotized and mineral matters are properly balanced, the plant will produce no more of each organ than is essential to the favourable production of its seed. Up to the period of blooming the compounds of nitrogen derived from ammonia are probably in a fluid or suspended state, circulating through the whole of the plant; but to what extent starch exists in the plant at this period is doubtful. When the time of blooming is passed, it is probable that the wheat derives but little nourishment from the soil, at all events, if a crop shows symptoms of poverty, it is always before this period. The circulating condition which has prevailed throughout the plant, is now changed, and under a favourable condition of climate (heat, light, and dryness) an elaborative action commences; the compounds of nitrogen are withdrawn from the leaf and stem, and deposited in the seed, while starch is accumulated in a hard granular form. This deposit of starch only takes place perfectly under the influence of a high temperature; the seed is then hard, dry, and plump. In a cold and wet summer the interstices of the grain are not perfectly filled; watery fluids occupy the place of starch, and, when these have evaporated, the grain is thin and shrunk. The wheat that is grown in a wet summer might therefore contain as high a per centage of nitrogenized matters dependent on the sap as that produced during a hot and dry season. The formation and elaboration of starch and other carbonaceous compounds which for the most part supply man with his respiratory or heat-producing elements, are, it seems, greatly favoured by a hot climate, and it is probable that the heat capable of being eliminated by the process of animal respiration, must first have been rendered latent during the growth of the plant.

Looking at the present state of man's existence on the earth, it may appear improbable that the value of corn should ever be in proportion to its carbonaceous product. A time may arrive, however remotely, when the surface of the earth will be peopled with men very far advanced both in their moral and physical condition, compared with its present occupants. Bread and meat will then constitute the chief sources of food—the one supplying respiration, the other nutrition; and they will doubtless bear a

more philosophical relation to each other all over the world than at present. The system of cultivation in England may be considered as tending to such a result more nearly than that of most other countries, and if the principles which it involves were properly understood and carried out, we might become independent of foreign supplies, even if our population were much greater than it is now. I have before stated that the ammonia in a manure is employed by grain-plants to determine carbonaceous products: the same principle is apparent in the economy of animals. Dr. R. D. Thomson, in his experiments, found that the cow which received the largest amount of nitrogen in its food produced the greatest weight of butter; and the general experience of agriculturists ascribes the most fattening properties to those substances which contain the greatest proportion of nitrogen. Although ammoniacal manures favour the elaboration of carbonaceous matters in grain, we might expect to find a different result in examining the seeds of the leguminous plants. The peculiarity of these plants is to produce a seed containing a highly nitrogenous element, called legumen. In our own experiments we find grain in the driest state contains one and two, but rarely three per cent. of nitrogen. We find in the dry substance of clover-seed as much as 7 per cent., and in beans and peas 5 per cent. The proportion of nitrogen in the seeds of these plants would, therefore, probably increase, within certain limits, under the influence of ammoniacal supply. The following results obtained by Dr. Gilbert seem to favour this view:—

	Per centage of Nitrogen in Dry Matter.	
	Exp. 1.	Exp. 2.
Beans grown by mineral manure	4·77	4·78
Beans grown by ammoniacal manure	5·11	5·09

In the seeds of cruciferous plants, turnips and rape for example, a non-nitrogenous product, oil, seems to abound, and we might expect that ammoniacal manures would tend to enhance its production in such plants, in like manner as that of starch is increased in the seeds of the gramineous family. Turnip-seed is not, however, cultivated in England with a view to its oily products, and I have only investigated the effect of ammoniacal supply upon the leaf and bulb of the plant.

In reference to the circumstances under which the formation of the special product of plants seem to be increased, a few remarks upon the cultivation of sugar-cane may not be out of place,

especially as there are so many agriculturists in this country who possess property in the West Indies, and the application of scientific principles would increase the production of sugar and reduce the expense of its cultivation to an extent not very readily imagined. Although sugar is found in almost every plant at certain periods of its growth, it is only extracted profitably from three or four, of which the cane is the most important. Sugar belongs to a class of carbonaceous substances, all of which are developed in the greatest perfection in the hottest regions. Among these are starch, gum, and oil; and although each plant possesses organs necessary to perfect its peculiar carbonaceous products, the same laws must govern the formation of them in all. In wheat I have shown that the carbonaceous product, starch, increases with a supply of ammoniacal manures, under the influence of a high temperature and the absence of rain; owing, however, to the moisture of our climate, and the want of that temperature which is required for producing and depositing starch, there are difficulties in the way of increasing this carbonaceous compound, which would not be met with if the same principles were applied to produce sugar in the cane. If I could depend upon a constant climate in England similar to that of 1846, I could produce annually 40 or 50 bushels of wheat upon an acre with the same facility that I now produce 33 or 34; but, as it is, were I to supply the proportion and quantity of mineral and organic manures necessary to produce 50 bushels, in a wet and cold summer—it would unduly develope the circulating condition of the plant, its vascular structure would be increased to an injurious extent, and the crop would be laid. Those who farm very highly have often experienced this misfortune, and consequently they dread a wet summer.

To the farmer whose land is out of condition, however, a wet summer is favourable, inasmuch as it increases the supply of those elements of which his crop is in need. In the sugar-cane the carbonaceous product is required in a circulating condition; therefore those substances should be applied as manures which increase the vascular action of the plant: at the same time the soil should be rendered as dry as possible by draining. In soils where the elements of fertility exist naturally, or where they are properly supplied in the manures, the richest juice and largest amount of sugar would be produced in the driest season. In the absence, however, of the proper amount of organic matter in the soil, the vital actions of the plant would, under the same climate and circumstances, be weakened. The combustion of the cane for fuel is a process which cannot be too much condemned. It involves the necessity of a much greater outlay in manures every year; for, if the mineral matter which remains after

combustion is restored at all to the soil, it is very much less efficacious than it would be if accompanied by the substance of the cane itself. In a well-regulated sugar plantation, non-nitrogenous products constitute the only export from the soil. The nitrogenous elements, which are rendered insoluble when the juice is heated, should be carefully removed, and either restored to the soil directly as manure or after being employed as food for animals.

The English farmer necessarily suffers an exhaustion of his soil from the removal of various ingredients which have not place in the constitution of sugar. In grain both nitrogen and phosphate are exported, both of which must be restored to the soil in due course. We hear of plantations which formerly produced many hundred hogsheads of sugar, now producing one-third the quantity. This can arise from nothing but exhaustion of the soil. It cannot be too generally known that the elaboration of carbon bears a very constant relation to the supply of ammonia in the manure. Every pound of sugar exported, and every pound of the cane which is burnt, involve the necessity of a supply of ammonia to the soil. Taking into consideration the immense advantage which a tropical climate affords, and the comparatively high price of the product, the cultivation of sugar offers advantages for the profitable employment of skill and capital greatly superior to any that our agriculturists can hope for. It would, however, be injudicious and improper, in defect of actual experiments, to attempt to lay down rules in detail for the application of a principle regarding which, as such, little doubt may be entertained.

I now come to the action of manures, which are generally divided into two classes—*organic* and *inorganic.* Although this distinction is by no means satisfactory, I shall adopt it as being generally understood. Organic manures are those which are capable of yielding to the plant, by decomposition or otherwise, organic matter—carbon, hydrogen, oxygen, and nitrogen—constituents which uncultivated plants derive originally from the atmosphere. Inorganic manures are those substances which contain the mineral ingredients, of which the ash of plants is found to consist. Most of the substances employed as manures contain both organic and inorganic substances. The greater portion of soils consist of minerals in a greater or less state of decomposition, combined with a small amount of organic matter. Every soil is capable of yielding a certain amount of vegetable produce under the influence of climate and season, without the assistance of manure: this may be called its natural produce. The proportion would vary each year, according to the amount of rain, the temperature of the

season, and the description of the growing plant. It is known, however, that although the climate of any place may vary one year as compared with another, it nevertheless maintains a certain average. It may be supposed therefore that the natural produce of the soil, in any particular locality, would be uniform in a series of years.

The effect of rain is to dissolve a certain portion of the mineral matter of the soil: it also supplies carbonaceous matter and ammonia. Liebig found ammonia in the rain at Giessen. The rain collected in a vessel placed on the top of a tree in my wheat-field, at a distance from any building, gave, upon evaporation, a liquid having a fœtid smell, and yielding ammonia to suitable re-agents. The rain collected in a rain-gauge placed in a garden at Mamhead, in Devonshire, had the taste of soot, although the wind was blowing direct from the sea during its fall. Rain is therefore capable, to a certain extent, of supplying plants with ammonia. Carbonic acid is also a constant and important constituent in rain-water, as well as in the atmosphere itself. The atmosphere may thus be considered the natural source of organic, and the soil that of inorganic, supply. It is the object of agriculture to increase the produce of the soil beyond its natural yield, which can be done by various means. The field may be fallowed—that is to say, the natural produce of the soil for two years may be concentrated into one—the repeated exposure of the soil to the atmosphere, by means of ploughing, causing a decomposition of mineral matter, while the ammonia in the rain unites with the various acids in the soil. The produce of the soil may also be increased by means of manures—that is to say, by supplying those ingredients which the soil and the atmosphere are incapable of yielding in sufficient quantity for an agricultural result. This process I shall now endeavour to explain. It will be remembered that the produce of wheat and straw upon the unmanured portion of my experimental field was greatest in the year when the atmospheric influence, and therefore the supply of ammonia, was the most; but in no case was a full agricultural crop obtained. This may be attributed to two causes: either that the wheat was incapable of assimilating what the atmosphere and rain could supply, for want of an available amount of minerals in the soil; or that the minerals in the soil were in excess, but that the wheat was incapable of assimilating them for want of a sufficient supply of ammonia, or other organic substances.

It has been argued by Liebig that the atmosphere can supply the ammonia from which plants derive their nitrogen, in sufficient quantity for agricultural purposes; and his views on this subject have been echoed through England by a host of his followers. This point, upon which so much difference of opinion exists be-

tween the French and German chemists, is perhaps the most important to agriculture which chemistry can solve. It affects the whole economy of cultivation, and the final solution of it must materially influence the actions of all practical agriculturists. With regard to the most important crop (wheat), my own experiments are so decisive, and through the whole series the results are so uniform, that it is hardly possible to have two opinions on the subject; and, what is still more important, they are in accordance with the dictates of reason and the practical experience of agriculture. The first year's experiments were drawn out principally with the view of ascertaining how far mineral manures were capable of restoring the fertility to a soil of which it had been deprived by repeated cropping. On the space of ground which was not manured, the acreage yield was as follows:—

Grain, 16¾ bushels; straw, 1120 lbs.

This may be considered as the natural produce of the soil, subject only to the atmospheric influence of that particular season. The next experiment was with 700 lbs. of superphosphate of lime, which gave—

Grain, 16¾ bushels; straw, 1116 lbs.

The superphosphate of lime employed in these experiments was made from calcined bone only, and was therefore strictly a mineral manure. By comparing this experiment with the last, it will be seen that no increase of produce was obtained.

The effect of superphosphate of lime upon wheat has been the subject of many experiments, and in some instances it has been employed with remarkable success. It becomes therefore of importance to inquire what was the probable cause of its inutility in this instance. Besides phosphoric acid and lime, the ash of wheat and wheat straw contains potash, magnesia, soda, and silica; and as superphosphate of lime contains none of these substances, its failure in this case may be attributed either to the absence of these minerals in the soil, or to a deficiency of azotized or other organic matter.

The average results obtained by other mineral manures are given below:*—

* The terms superphosphate of lime, phosphate of potass, phosphate of soda, and phosphate of magnesia, by which it is convenient to designate the manures, are not to be understood as representing the pure chemical substances bearing those names. The composts were formed by acting upon bone-dust by means of sulphuric acid, in the first instance, in the cases of the alkaline salts and the magnesian salt, neutralizing the compounds thus obtained by means of cheap preparations of the respective bases. The silicate of potass was manufactured at a glass-house by fusing equal parts of pearl-ash and sand—a clear transparent glass, slightly deliquescent in the air, was the result; it was ground to powder under edge-stones.

	Bushels of Grain.	Pounds of Straw.
Superphosphate of lime, 350 lbs.; phosphate of magnesia, 420 lbs.	$16\frac{1}{5}$	1100
Superphosphate of lime, 350 lbs.; phosphate of soda, 325 lbs.	$16\frac{3}{4}$	1172
Superphosphate of lime, 350 lbs.; phosphate of potass, 375 lbs.	$16\frac{1}{4}$	1160
Superphosphate of lime, 560 lbs.; silicate of potass, 220 lbs.	$16\frac{4}{10}$	1112
Superphosphate of lime, 350 lbs.; phosphate of magnesia, 210 lbs.; phosphate of soda, $162\frac{1}{2}$ lbs.	$16\frac{3}{4}$	1116
Superphosphate of lime, 350 lbs.; phosphate of magnesia, 210 lbs.; phosphate of potass, 187 lbs.	$17\frac{1}{2}$	1204
Superphosphate of lime, 350 lbs.; phosphate of magnesia, 210 lbs. silicate of potass, 275 lbs.	17	1176
Superphosphate of lime, 350 lbs.; phosphate of magnesia, 168 lbs.; phosphate of potass, 150 lbs.; silicate of potass, 110 lbs.	$17\frac{8}{10}$	1240

The greatest increase obtained by these mineral manures over the natural produce of the soil was less than 2 bushels of wheat and 84 lbs. of straw. The effect of minerals obtained from a more natural manuring source (the combustion of dung), gave a similar result. A quantity of farm-yard dung was weighed into two portions, at the rate of 14 tons each per acre, one being burnt to ashes, and the other ploughed into the soil. The results were as under :—

	Bushels of Grain.	Pounds of Straw.
14 tons of farm-yard dung	22	1476
Ash of 14 tons of farm-yard dung	16	1104

The absence of any agricultural increase of produce throughout this series of experiments might be said to arise either from some defect in the mineral constitution of the manures, or from the minerals in the soil not being in a proper state for the wheat to assimilate them; but if, as is seen in the following table, the addition of an ammoniacal salt can produce an increase of corn and straw to a considerable extent, the minerals must have been in a state available for the plant :—

	Bushels of Grain.	Pounds of Straw.
1. Superphosphate of lime, 635 lbs.; sulphate of ammonia, 65 lbs.	$21\frac{1}{4}$	1368
2. Superphosphate of lime, 350 lbs.; phosphate of magnesia, 84 lbs.; phosphate of soda, 75 lbs.; silicate of potass, 110 lbs.; sulphate of ammonia, 65 lbs.	$21\frac{1}{4}$	1480
3. Superphosphate of lime, 350 lbs.; phosphate of magnesia, 84 lbs.; phosphate of soda, 75 lbs.; silicate of potass, 110 lbs.; rape-cake, 156 lbs.	$22\frac{3}{4}$	1768
4. Superphosphate of lime, 350 lbs.; phosphate of magnesia, 106 lbs.; phosphate of soda, 80 lbs.; silicate of potass, 110 lbs.; sulphate of ammonia, 80 lbs.	$26\frac{1}{4}$	1772

On comparing the produce of No. 1 in this table with that of the superphosphate of lime as given elsewhere, it will be seen that the substitution of 65 lbs. of superphosphate of lime by 65 lbs. of sulphate of ammonia has caused an increase of 4½ bushels of corn, and 248 lbs. of straw. Again, the increase shown in No. 4, where 80 lbs. of sulphate of ammonia were employed, is from 8 to 9 bushels of corn, and about 600 lbs. of straw, over the produce of the best mineral conditions as given in a former table.

The evidence afforded in these experiments regarding the importance of ammoniacal manures caused us to discontinue the employment of mineral manures alone in the second year. It was highly desirable to ascertain whether the minerals supplied during the first year, and also those naturally contained in the soil, were capable of being taken up by future crops. For this purpose ammoniacal salts alone were subsequently employed on some of the plots:—

Season.	Same Space of Ground each Year.	Grain.			Straw.
		Bush.	Pks.	Qts.	Pounds.
1844	Superphosphate of lime, 560 lbs.; silicate of potass, 220 lbs.	16	0	0	1112
1845	Sulphate and muriate of ammonia, each 1½ cwt.	31	3	1	4266
1846	Sulphate of ammonia, 2 cwt.	27	1	2	2244

From the immense increase, both of corn and straw, obtained in the second and third years, without any fresh addition of minerals, it is evident that the deficient produce in the first year could only result from the want of some power in the plant to assimilate those already at its command, and that such a power was not wanting in the succeeding years.

I shall only notice one more set of experiments in connection with this point, and which were tried in the season of 1846 with the wheat manure patented by Professor Liebig, and prepared and sold under his name and authority. On referring to the specification of his patent, it will be seen that his object is to reduce the solubility of the alkalies by fusing them with lime and phosphate of lime, and to employ those substances which will form a compound resembling the ash of wheat:—

	Grain.			Straw.
	Bush.	Pk.	Gal.	Pounds.
1. Unmanured acre	17	3	3	1513
2. 4 cwt. of Liebig's wheat-manure alone	20	1	2	1676
3. 4 cwt. of Liebig's wheat-manure, with 4 cwt. rape-cake	22	3	1	1968
4. 4 cwt. of Liebig's wheat-manure, 1 cwt. each of sulphate and muriate of ammonia	29	0	3	2571
5. 4 cwt. of Liebig's wheat-manure, 4 cwt. rape-cake, 1 cwt. each of sulphate and muriate of ammonia . . .	31	3	0	3067

The superiority which Liebig's manure, when used alone, exhibits, as compared with the result of the unmanured space, may be attributed to its containing a small quantity of ammoniacal matter, which was distinctly perceptible to the smell.

The absolute necessity of supplying nitrogen to enable the soil to produce more wheat than it could do in a natural state, is so apparent throughout this series of experiments, that it is difficult to entertain the slightest doubt upon the subject. As long as any available ammonia exists in the soil, so long will mineral manures increase the produce of wheat. If I had commenced my experiments upon a field in high condition, full of animal and vegetable matter, I might have been some years in arriving at the true action of mineral manures: as it was, the first year almost decided the question.

For the last seven years this field has suffered an immense loss of minerals, rendered available to the plant by means of ammonia; and the produce of last year (1846) showed that the mineral condition was still little impaired. The crop now growing shows, however, symptoms of an opposite condition of soil. In some experiments, where no minerals have been supplied, the salts of ammonia are not producing their accustomed effect: an excess of the azotized condition is commencing, and mineral manures will now have to be employed to increase the natural produce of the soil.

The various contradictory results obtained by the application of mineral manures to wheat are completely accounted for when it is known that they only increase the produce in proportion to the available azotized matter existing in the soil. Although I have confined my remarks to the wheat crop, they apply equally to the whole class of plants belonging to the same "natural order." Though they do not thrive equally well in the same climate and soil, I consider them all to be plants in which the nitrogen supplied in the manure is more than what is obtained in the produce. They may for our present purpose be called nitrogen-consuming plants, in contradistinction to those which are nitrogen-collecting plants, and contain more of this substance than was supplied to them in the manure. Common pasture belongs to the same class of plants as our grain crops: hence we have an additional argument to the number already advanced, in favour of breaking it up in every case where it is not required for ornamental purposes.

The theory advanced by Liebig, that "the crops on a field diminish or increase in exact proportion to the diminution or increase of the mineral substances conveyed to it in manure," is calculated so seriously to mislead the agriculturist that it is highly important its fallacies should be generally known. The contempt which the practical farmer feels for the science of

agricultural chemistry arises from the errors which have been committed by its professors. They have endeavoured to account for, and sometimes to pronounce as erroneous, the knowledge which ages of experience have established; and they have attempted to generalise without the practical data necessary to accomplish their end with success. Agriculture will eventually derive the most important assistance from chemistry, but before it can propose any changes in the established routine of the farmer, it must, by a series of laborious and costly experiments, explain this routine in a satisfactory manner.

Although the experimental results which have been detailed undoubtedly prove that to produce agricultural crops of corn nitrogen must be supplied to the soil in some form or other, two important questions still remain unanswered, namely, first, what amount of ammonia will be required to produce a given amount of corn? or, in other words, what amount of nitrogen must the farmer accumulate in his soil to obtain each bushel of corn beyond the natural produce? Secondly, what are the most economical means at his disposal for securing the necessary supply? The solution of these questions is within the reach of careful experiment and calculation; and, although any data at present at our disposal may be incompetent to a proper treatment of them, it may serve some useful purpose to apply such results as we possess with the view of directing some general and approximative knowledge on points bearing so essentially on the economy of agriculture.

It may be considered for our present purpose that a bushel of wheat contains one pound of nitrogen. It must not be supposed, however, that $1\frac{1}{5}$ lb. of ammonia (equivalent to one pound of nitrogen) supplied to the soil, will, even under the most favourable circumstances, add a bushel to its natural produce. Throughout the whole course of my experiments upon the growth of wheat by means of ammoniacal salts there has been a loss of nitrogen far too great to be attributed merely to drainage and evaporation from the land; and it is possible that a better knowledge than we now possess of the vital actions of plants will, sooner or later, throw much light upon this interesting and highly important phenomenon. I am inclined to think that, for practical purposes, we may assume 5 lbs. of ammonia to be required for the production of every bushel of wheat beyond the natural yield of the soil and season; at any rate, it will be useful to remember this as the amount until future experiments shall furnish further information on the subject. In the following table, p. 248, are arranged some of the results obtained last year (harvest, 1846) in my experimental wheat-field.

Besides the bearing which these results have upon other points

than that of the amount of ammonia required to produce a bushel of corn, they will enable any one to judge of the probable exactness of the estimate which has just been made. It should be remembered, however, that as the season of 1846 was more than usually favourable to the production of corn, any calculations founded upon the results of that year might lead to an over-estimate of what the ammonia would produce in an average of years. The produce of the unmanured space and that of farm-yard dung was—

	Bush.	pks.	gals.	Straw in lbs.
No manure . .	17	3	3	1513
14 tons of dung . .	27	0	3	2454

It was my intention to conclude this paper with some experimental evidence relative to the influence of climate and manures upon the turnip and leguminous crops; but, having extended my observations upon the corn-plants to a greater length than I had at first contemplated, I shall defer the consideration of that subject to a future period. I wish, however, to make a few observations upon the general principles of practical agriculture. Some of them are apparent from the evidence I have already brought forward, but some of them are indicated by the results of other branches of the investigation than those which I have discussed in the foregoing pages.

I have said that soil and atmosphere are the two great natural sources from which plants derive the elements of their growth; the former supplying the inorganic and the latter the organic elements. Besides the minerals of which soils are principally composed, they contain a certain amount of organic matter capable of yielding carbon and ammonia to plants; and the annual amount of ammonia which a soil is competent to yield under the influence of the atmosphere must to a certain extent determine its natural fertility. A Russian soil, said to be one of the most fertile in the world, and which yields fine wheat without manure, gave when analysed by M. Peyen, 24½ lbs. of nitrogen in 1000 lbs. of soil, or nearly 2½ per cent. A very fertile soil sent to me by Sir John Tylden from Somersetshire, and said to yield 40 bushels of wheat annually without manure (a statement afterwards proved to be incorrect), was analysed by Dr. Gilbert in my laboratory, and gave 6·2 lbs. of nitrogen in 1000, or rather more than ½ per cent.; whilst from the soil of my experimental field, which yields about 17 bushels of wheat annually without manure, he obtained in 1000 parts only 2·0 of nitrogen, equal to 1-5th per cent. Although the amount of nitrogen in a soil, independently of any immediate supply, may determine to a certain extent its powers of producing corn, it is not a sure criterion of the value of different descriptions of soil. The rich clayey soils, in which the largest

Selected Results of Experiments upon the Growth of Wheat by means of Artificial Manures; 3rd Season. Harvest 1846.

Numbers.	Description of Mineral Manures—Acreage Quantities given.	Bushels, Pecks, and Quarters per Acre.				Straw per Acre in lbs.			
		The Mineral Condition only.	Mineral Condition, and 4 cwts. Rape Cake.	Mineral Condition, and 2 cwts. Ammoniacal Salts.	Mineral Condition, 4 cwts. Rape Cake, and 2 cwts. Ammoniacal Salts.	The Mineral Condition only.	Mineral Condition, and 4 cwts. Rape Cake.	Mineral Condition, and 2 cwts. Ammoniacal Salts.	Mineral Condition, 4 cwts. Rape Cake, and 2 cwts. Ammoniacal Salts.
		bush. p. q.	bush. p. q.	bush. p. q.	bush. p. q.	lbs.	lbs.	lbs.	lbs.
1	2 cwts. Calcined Bone-dust . . .	..	23 3 1	29 0 3	..	..	1963	2575	..
2	Ditto, ditto, and 2 cwts. Hydrochloric Acid	..	..	*25 3 3	*31 1 3	..	..	*2390	*2936
3	Ash of 3 loads Wheat Straw . . .	19 0 2	23 2 2	*27 0 0	*30 0 3	1541	1721	*2309	*2901
4	4 cwts. Liebig's Manure for Wheat .	20 1 2	22 3 1	29 0 3	31 3 0	1676	1968	2571	3007
5	No Mineral Manure (exhausted land)	17 2 2	23 2 3	*27 1 2	*28 3 2	1455	2033	*2244	*2603
6	2 cwts. Calcined Bone-dust, 2 cwts. Sulphuric Acid	..	23 1 3	30 0 1	..	..	2133	2715	..
7	Ditto, ditto, and 180 lbs. Soda Ash .	..	24 1 2	28 2 3	..	..	2163	2554	..
8	Ditto, ditto, and 200 lbs. Pearl Ash .	..	24 0 0	29 1 3	..	..	2327	2755	..
9	Ditto, ditto, and Magnesian Limestone	..	23 2 2	26 2 2	..	..	2031	2534	..
10	Ditto, ditto, and 60 lbs. Soda Ash, 68 lbs. Pearl Ash and Magnesian Limestone	22 1 0	23 3 0	*30 2 0 31 0 0	*30 1 0 33 2 2	..	2067	*2784 2838	*2836 3278
	Mean results	19 3 2	23 2 1	28 0 0	31 0 0	1704	2045	2546	2925

* Denotes that the ammoniacal salt employed was entirely *sulphate*; in other cases, 1 cwt. *each* of sulphate and muriate were used.

It is to be regretted that, with a view to some interesting points of comparison, the same salt of ammonia was not employed throughout the entire series; the muriate containing a higher per centage of ammonia than the sulphate, its effect might be expected to be somewhat greater, and this indeed is seen to be the case. The series with Liebig's manure (besides the small amount of ammonia it itself contains) may owe its slight superiority over the straw-ash series to the one where no mineral manure was employed, partly to the use of muriate, as well as sulphate of ammonia; on the other hand, the series No. 10 has the advantage over No. 4 throughout.

Selected Results, &c.—*continued.*

No.	Total Weight of Corn per Acre in lbs.				Weight of Dressed Corn per bushel.				Per Centage of Corn to Straw.			
	The Mineral Condition only.	Mineral Condition, and 4 cwts. Rape Cake.	Mineral Condition, and 2 cwts. Ammoniacal Salts.	Mineral Condition, 4 cwts. Rape Cake, and 2 cwts. Ammoniacal Salts.	The Mineral Condition only.	Mineral Condition, and 4 cwts. Rape Cake.	Mineral Condition, and 2 cwts. Ammoniacal Salts.	Mineral Condition, 4 cwts. Rape Cake, and 2 cwts. Ammoniacal Salts.	The Mineral Condition only.	Mineral Condition, and 4 cwts. Rape Cake.	Mineral Condition, and 2 cwts. Ammoniacal Salts.	Mineral Condition, 4 cwts. Rape Cake, and 2 cwts. Ammoniacal Salts.
	lbs.	lbs.	lbs.	lbs.	bush.	bush.	bush.					
1	..	1549	1988	..	..	63·5	63·6	..	..	78·9	77·2	..
2	..	..	*1777	*2112	..	..	*63·5	*62·5	..	..	*74·3	*71·9
3	1305	1598	*1827	*2076	63·7	63·4	*63·0	*63·3	84·6	92·8	*79·1	*71·6
4	1400	1534	1967	2163	63·7	63·0	63·5	63·4	83·6	77·9	76·5	72·6
5	1216	1614	*1850	*1942	63·8	63·5	*63·6	*63·3	83·6	79·4	*82·4	*74·6
6	..	1628	2055	..	..	63·3	63·2	..	..	76·3	75·7	..
7	..	1661	1955	..	..	63·0	63·4	..	..	76·8	76·5	..
8	..	1660	1998	..	..	63·5	63·2	..	..	71·3	72·5	..
9	..	1605	*1812	2019	..	63·0	63·4	..	..	79·0	*71·5	..
10	1474	1592	2048	2241	62·0	62·0	{*63·0 62·75}	{*62·7 62·8}	77·1	77·0	{*70·3 72·2}	{*71·2 68·3}
	1349	1605	1753	2092	63·3	63·1	63·3	63·0	82·2	78·8	76·2	71·7

Selected Results, &c.—*continued.*

No.	Increase in Corn by Manure.				Increase in Straw by Manure.				Increase in Total Produce by Manure.			
	The Mineral Condition only.	Mineral Condition, and 4 cwts. Rape Cake.	Mineral Condition, and 2 cwts. Ammoniacal Salts.	Mineral Condition, 4 cwts. Rape Cake, and 2 cwts. Ammoniacal Salts.	The Mineral Condition only.	Mineral Condition, and 4 cwts. Rape Cake.	Mineral Condition, and 2 cwts. Ammoniacal Salts.	Mineral Condition, 4 cwts. Rape Cake, and 2 cwts. Ammoniacal Salts.	The Mineral Condition only.	Mineral Condition, and 4 cwts. Rape Cake.	Mineral Condition, and 2 cwts. Ammoniacal Salts.	Mineral Condition, 4 cwts. Rape Cake, and 2 cwts. Ammoniacal Salts.
1	..	342	781	..	..	450	1062	..	..	792	1843	..
2	..	..	*570	*905	..	..	*877	*1423	..	..	*1447	*2328
3	97	391	*620	*869	28	208	*796	*1388	125	599	*1416	*2257
4	193	327	760	956	163	405	1058	1494	356	732	1818	2450
5	..	407	*643	*735	..	520	*731	*1090	..	927	*1374	*1825
6	..	421	848	..	..	620	1202	..	..	1041	2050	..
7	..	454	748	..	..	650	1041	..	..	1104	1789	..
8	..	453	791	..	..	814	1242	..	..	1267	2033	..
9	..	398	605	..	..	518	1021	..	..	916	1626	..
10	267	385	{*827 841}	{*812 1034}	380	554	{*1270 1325}	{*1323 1765}	647	939	2166	2799
	183	397	721	885	190	526	1020	1420	343	924		

The acreage produce, as will be seen by inspection, is arranged in four columns, and the manures, the detail of which is given on the left of the figures, were used alone, or with additions, as indicated by the several headings. The effects of the different mineral manures, whether alone or with artificial supply of organic constituents, are thus readily seen by casting the eye *down* each column; and those of different conditions of organic with the same mineral supply are found in a line *across* the four columns.

stores of nitrogen are generally found, are exactly those which derive the least benefit from a rotation of crops. The amount of nitrogen existing in a sandy soil may hardly be appreciable by analysis, but by the free circulation of air through its pores, the accumulation from the resources of the atmosphere through the medium of green crops, and especially of turnips, to a certain extent counterbalances the deficiency. The actual value of a turnip crop must vary very much, according to the texture of the soil. On heavy clays, the decomposition of soil by means of a summer-fallow aided by lime, will often render available more ammonia as well as mineral mixtures, than could be obtained by means of a turnip-crop. Upon light soils, however, nothing can advantageously substitute the collective powers of the turnip. In one soil the accumulation of available stores may be effected by combustion or lime, in the other they must be supplied by a different process. As almost every soil contains mineral matter in an undecomposed state, it must evidently be advantageous to favour its liberation by every possible means; for the more produce a soil can be made to yield without manure, the less manure it will require to bring its produce up to a maximum. It was at one time supposed that by repeatedly hoeing and stirring the soil, it could be made to yield perpetual crops without manure; and although this was carrying the principle too far, it undoubtedly proves the benefit of mechanical operations. Draining, however, offers advantages to the agriculturist superior to any as a means of obtaining the influence of the atmosphere upon the soil. Not only is the surface of the soil exposed to the action of the air, but its influence extends to the depth of the drains themselves. In addition to this advantage, what may be considered as an artificial climate is to some extent obtained. An increased temperature, and the absence of moisture, conditions so essential to the production of grain of fine quality, are the result of draining the soil. Thermometers placed in two soils equally exposed to the sun's rays, one of which is moist and the other dry, indicate very different degrees of temperature. The rays of the sun, which only serve to evaporate moisture in the one, will raise the temperature of the other. It follows that plants would grow more rapidly upon a well-drained soil than upon one in an opposite condition, especially during the spring. It will be remembered how large a quantity of ammonia I found it necessary to supply to my soil each year to restore the substances removed in the previous crop. Besides being expensive, this ammonia cannot be procured in the market in any large quantities; but by cultivating turnips and the leguminous plants, a large amount of this substance is collected by them from the atmosphere. A rotation of crops may in one sense therefore be considered as an economical process for

obtaining ammonia; but as the amount obtained by green crops must depend very much upon their bulk, every attention should be paid to their growth. In order to produce the greatest weight of turnips, it is necessary that the soil should be brought to the finest and lightest condition possible by mechanical means, and that it should be manured by a large and available supply of carbon and phosphates. Ammonia artificially supplied is not essential if the soil be not deficient in carbonaceous substances; and where the phosphates are not supplied in sufficient quantity it exerts a most injurious effect upon the plant.

The turnip is essentially a plant which requires artificial aid for its development in agricultural quality and quantity. It is singular that while my soil yields 17 bushels of wheat annually, without manure, the turnips upon an unmanured space were reduced to a few cwt. per acre in three years, and in the fourth only averaged the size of a radish. It is also remarkable that a plant whose office it is to restore fertility to the soil should scarcely be able to exist where wheat was yielding a tolerable crop; but the different effect produced upon two crops by farm-yard dung and superphosphate of lime at once explains this anomaly. Eighty-four tons of farm-yard dung, consisting of decaying straw mixed with the excrement of the farm-horses, applied to one acre of wheat and one of turnips during three years, at the rate of 14 tons per acre per annum, did not, in the acre of wheat, add much more than one-half to the natural produce each year: the turnips, however, were increased to an indefinite extent. Superphosphate of lime, which produced no increase of wheat the first year it was applied, gave in succession three good crops of turnips. The dung which I applied to my wheat increased the produce to an extent equivalent to the amount of ammonia which it may be estimated to contain; but it is evident that the great bulk of 42 tons served little useful purpose, for we find that salts of ammonia have produced each year a larger amount of corn. The whole of the solid matter of the residue, consisting of organic matter almost destitute of nitrogen, could have been assimilated by the turnip, under the influence of a due supply of phosphates. On poor soils it is quite consistent with scientific principles to employ rich azotized dung for the wheat crop, and to convert the carbonaceous residue into the substance of the turnip by an abundance of phosphates. It would, however, probably be advantageous to have a greater proportion than one-fourth of the farm under turnips each year. At present, upon the Norfolk system one-fourth of the farm is clover, but broad clover cannot be obtained with certainty so often. If instead of this, one-eighth of a farm was clover and three-eighths turnips, a larger proportion of winter food would be obtained, and as

much clover grown upon an eighth as has hitherto been grown upon one-fourth of the farm. We have no reason to suppose that one grain crop possesses the power of exhausting the soil more than another. The tenant-farmer should therefore be permitted to grow that crop which is most suited to his soil. On the heavy soils alternate wheat crops might be grown; oats might also be substituted for barley with advantage, whenever the soil has been rendered incapable of complete pulverization, by consuming the turnips upon the land in wet weather.

Having, I trust, shown upon scientific principles that a rotation of crops is indispensable in order to carry out a system of practical and economical agriculture, I shall now endeavour to prove by a few brief observations that to obtain the greatest possible produce from the soil, the production of meat ought to bear a definite relation to the amount of grain exported.

The philosophical considerations to which this subject naturally leads are of the highest interest; but as it would be impossible to treat of them at once clearly and at the same time as briefly as our present object permits, it will be best to turn our attention to some of the more practical bearings of the question.

In feeding stock but a small proportion of the nitrogen in the food is converted into the substance of the animal; the greater portion is restored to the soil as manure. The economy of the production of meat as a means of obtaining manure arises from the greatly increased value of the nitrogen in flesh, as compared with that supplied in the food. Thus 28 lbs. of flesh, worth 14*s*., contains 1 lb. of nitrogen—28 lbs. of peas, beans, or oil-cake, which contain about the same quantity, are not worth more than 2*s*. or 3*s*. To determine the exact proportion of the meat, or rather the live weight of stock which must be produced upon any farm to obtain the greatest possible produce of grain, requires a long and careful series of investigation.

With the exception of one experiment performed by Boussingault, we have no data from which we can calculate the loss of carbon and nitrogen which a farm sustains by the vital processes of the animals fed upon it, but it is evident that it is most serious. In Boussingault's experiments it appeared that a cow respired in 24 hours as much dry organic matter as was equivalent to 100 lbs. of turnips. This forms a strong argument in favour of the modern system of fattening animals rapidly by means of artificial food. When turnips are plentiful and stock is dear, farmers not unfrequently give their turnips to any person who will bring stock to consume them. And it is a common practice in some places to feed a quantity of half-starved cattle upon straw for the purpose of converting it into dung. It should, however, be understood that the passage of the straw

or turnip through the stomach of the animal, far from adding to the quality of these substances as manure, abstracts a large proportion of their valuable elements. There is no magical property in the black mass called dung which did not exist in the straw. Some of the elements may be rendered more rapidly available by the decomposing agency of the animal; but the actual quantity restored to the soil must be considerably reduced. In all cases, therefore, where artificial food is not employed, or when the consumption of food is not attended with profit, it is better to restore the superabundance of green crop more directly to the soil for the after-growth of corn, whilst any residue of our corn crops, if it cannot be used as litter, will, if returned to the soil in its natural state, or after suffering decomposition between layers of earth, supply constituents to the succeeding fallow crop.

The increase of meat obtained by any particular food must vary to a certain extent, with animals of different breeds and ages, as well as with the care and attention bestowed upon them. There is, however, in all cases, a relation sufficiently evident, between the increase of the animal and the nitrogen in the food, to enable us to form some calculation upon the relation which should exist between the production of corn and that of meat upon a well cultivated farm. In illustration of this statement, in the first place I may refer to some experiments made upon the farm of the Earl of Radnor, regarding the feeding qualities of different breeds of sheep. The results are quoted from the last number of this Journal.

In the 1st experiment, 20 sheep received 847 lbs. of hay, 1319 lbs. pulse, and 25,293 lbs. swedes, and the increase of live weight was 400 lbs. In the 2nd experiment 1044 lbs. of hay and 17,254 lbs. of turnips produced 192 lbs. of meat. Calculating the nitrogen consumed by the first lot, to be in the hay $8\frac{1}{2}$ lbs., in the pulse 45 lbs., in the turnips 38 lbs., and taking the per centage of nitrogen in the increase of live weight at $3\frac{1}{2}$, we have in the first experiment—

$91\frac{1}{2}$ lbs. of nitrogen supplied in the food.
14 lbs. do. converted into flesh.

Upon similar calculations the 2nd experiment gives—

35 lbs. of nitrogen supplied in the food.
7 lbs. do. converted into flesh.

In the first experiment 1 lb. of nitrogen produced $4\frac{1}{3}$ lbs. increase of flesh, and in the 2nd, 1 lb. of nitrogen produced 5 lbs. increase; not making any allowance for the probable loss by the vital processes of the animals, and in the preparation of the dung, we have for each pound of nitrogen exported, as much in the first experiment as $6\frac{1}{2}$ lbs.; and in the 2nd, 5 lbs. remaining for manure.

In the 'Gardener's Chronicle,' for the year 1844, are given the results of some experiments upon feeding sheep conducted upon the farm of the Earl of Ducie, by Mr. Morton; some of these sheep were fed in the field, some under cover. Altogether 25 sheep were experimented upon, and they increased 611 lbs., having consumed 31,580 lbs. of swedes, 2775 lbs. of oats. Calculating the food to have contained 95 lbs. of nitrogen, and the increase of live weight to represent 21 lbs. of nitrogen, 1 lb. of nitrogen produced $6\frac{1}{2}$ lbs. of live weight, and for each pound of nitrogen exported in meat, $3\frac{1}{2}$ remain for manure.

In an experiment of my own, two pigs which consumed food, containing by analysis $12\frac{1}{2}$ lbs. of nitrogen, increased in weight 71 lbs. This gives about $5\frac{3}{4}$ lbs. increased live weight, and for every pound of nitrogen exported in meat, and about 4 lbs. remain for manure.

In Bacon's Essay on the Agriculture of Norfolk, there is a table of the feeding qualities of oil-cake and swedes, compared with a compound of boiled linseed with peas and swedes; six oxen were selected for each trial, and the live weight of each beast was taken at the commencement and the end of the experiments.

The following are the results:—

1.—6 oxen consumed 106,792 lbs. turnips, 3,712 lbs. peas, 1,110 lbs. linseed.

The increase of the live weight being 1,722 lbs.

2.—6 oxen consumed 108,440 lbs. turnips, and 6,183 lbs. oil-cake.

The increase of the live weight being 1,310 lbs.

In the 1st lot the nitrogen in the food was about 335 lbs., 1 lb. of nitrogen gave 5 lbs. of increase live weight, and for each pound of nitrogen exported $4\frac{1}{2}$ lbs. remained for manure.

In the 2nd lot, the nitrogen in the food was 389 lbs., 1 lb. of nitrogen gave $3\frac{4}{10}$ increase, and for each pound of nitrogen exported $7\frac{1}{2}$ remain for manure.

In consequence of turnips being employed as part of the food, in all the results which I have given, it is impossible to make any calculation respecting the economy arising from fatting cattle as a means of obtaining manure, without first deciding at what expense turnips can be produced. Upon this subject very great difference of opinion exists amongst agriculturists, and indeed the effects of soil and season so materially affect the question, that it is scarcely safe to make any calculations respecting it. Some would value them as low as 7*s.* per ton, some as high as 20*s.*

By the kindness of a friend, however, I have been provided with some results obtained by feeding upon marketable food alone. As the results extend over a considerable number of

years, in each of which 30 to 40 oxen were fatted, they may be considered to afford very trustworthy information on the subject.

Each ox received for 22 weeks 20 lbs. of the best clover hay, and 10 lbs. of English oil-cake per day. They sold for 9*l.* more than they cost, and the average loss upon each was 4*l.* 12*s.*

Each ox received	3080 lbs. of hay =	nitrogen	49 lbs.
	1470 lbs. oil-cake	do.	70 lbs.
		Total nitrogen	119 lbs.

Estimating the increase in live weight according to the increase in money value at 576 lbs., and the nitrogen to amount to $3\frac{1}{2}$ per cent. of their weight, we have 20 lbs. of nitrogen in the meat.

1 lb. of nitrogen gives nearly 5 lbs. of increase live weight, and for each pound of nitrogen exported 5 lbs. remain for manure.

99 lbs. of nitrogen remaining for manure are equivalent to 120 lbs. of ammonia.

To supply the 120 lbs. of ammonia in Peruvian guano of average quality, it would certainly require more than half a ton of that manure, which at the present time would cost 5*l.* The price of ammonia thus obtained would be 10*d.* per lb.

In my experiments upon wheat, it required 5 lbs. of ammonia to produce a bushel of corn. To obtain this amount of ammonia by means of stock, there should be an increase of about 28 lbs. of live weight upon the farm; or in round numbers, to obtain 1 ton of grain beyond the natural production of the soil, there ought to be an increase in the weight of stock of 1000 lbs. In order to bring an exhausted soil to the highest state of fertility, it will be necessary to produce an amount of meat by means of imported food (such as hay and oil-cake) as will be equivalent to the increase of grain required. As the green crops increase year by year, the same amount of meat will be produced, but the importation of artificial food will gradually decrease to the point at which the internal and external resources of the farm are so balanced as to secure the largest amount of produce from the soil.

I have not tried the comparative feeding qualities of the leaf and the bulb of the turnip; but from the much higher per centage of nitrogen in the former, as determined by analyses in my laboratory, it may be inferred that it is much more nutritive. This would be the case more particularly with the late-sown turnips, when the circulation of the fluids in the leaf is still active, and the plant has not had time to produce a full-sized bulb. It is possible, however, that the relatively low state of elaboration of the constituents of the leaf might interfere with its otherwise evident applicability as a healthy food.

According to the rule which has been assumed—namely, that the production of 1000 lbs. of live weight increases the yield of

grain by 2240 lbs.—the production of 576 lbs. of live weight, as in the cases of the oxen cited above, would give 1290 lbs. increase in grain, equal to 21 bushels of wheat.

This method of fattening bullocks may be considered as the most expensive the farmer can adopt. The whole of the food employed (hay and oil-cake) may be viewed as manufactured articles: it is evident, nevertheless, that artificial manures would have been a dearer source of ammonia than that afforded by the feeding of the animals; but when the other constituents of the several manures are taken into account, the balance will be still more in favour of the fatting process. The dry matter contained in the food of the ox was nearly 4000 lbs; and of this quantity, deducting the little that was converted into the substance of the animal, the only remaining reduction, if the dung be properly manufactured, is in the carbon respired by the animal, which, under the system of agriculture here advocated, is a consideration of no moment. It may appear to some agriculturists that I have entered into details on this subject which are both tedious and unnecessary, but I would solicit a careful consideration of them. I do not at all imagine that the precise relations of ammonia to increase of corn, and of nitrogen in food to nitrogen of live weight obtained, are really such as have been assumed for the purposes of illustrating the views advocated in this paper. My object is to establish as a principle, by which practical agriculture should be guided, that the amount of meat or live weight of stock produced upon a farm, should bear a fixed relation to the quantity of corn exported.

If the truth of this postulate be once established, and the proper proportions fixed, it will no longer be necessary to enforce upon the farmer any particular rotation of crops. So long as a due relation between his production of meat and export of corn were maintained, there would be no fear of an exhaustion of the soil, even if he grows no green crops whatever; and he might safely be left to make his own choice of the means he would adopt. His object being the production of a certain amount of meat at the lowest possible expense, he would naturally devote his energies to the production of large green crops, in order to limit his outlay in artificial food. Knowing, too, the most profitable conditions upon which his corn could be raised, his chief attention would be paid to the economical supply of food for his stock, in full confidence as to the consequences of his course. In objection to any rule which may assume a necessary relation between the production of meat and that of corn, it may be maintained that were any cheap and inexhaustible source of ammonia discovered, the production of meat, as the means of exporting corn, should be materially lessened. The difficulties, however, which we may

fairly calculate upon as standing in the way of such a consummation, as well as the physiological and commercial considerations which would be involved in its influence, are such that we need not now anticipate the result. Again, the supposition that the artificial manures at present at our command, might, if directly applied to the growth of corn, be adequate to its sufficient production throughout the country, without the aid of green crops in feeding, is satisfactorily met by such calculations as the following:—The county of Norfolk is said to comprise 1,338,880 acres of land: suppose one-half of this to be cultivated on the four-course system, 334,720 acres will be under corn every year. I believe it will not be considered an exaggeration to say that cultivation in this county has increased the natural produce of corn by 10 bushels per acre; and according to my calculations, it would require something like 50 lbs. of ammonia to be supplied in any artificial manure to produce this increase of corn; and considering 1 ton of Peruvian guano to contain 224 lbs. of ammonia, it would require an importation of 74,714 tons to supply the necessary amount for one year. This calculation affords some idea of the value of a rotation of crops.

It is not very difficult to arrive at a correct knowledge of the action and value of artificial manures. They are generally composed of two or three ingredients in a state of concentration, and are far more rapid in their action upon plants than the manure which is produced by animals. They can therefore be applied with greater success to those crops which are required in an artificial condition, and the growth of which cannot be too vigorous.

If there be any truth in my experiments, all hope of obtaining annual crops of corn by means of mineral manures must be for ever abandoned. The employment of potash, soda, magnesia, and silica, has been suggested by chemists, from an imperfect knowledge of practical agriculture. Having found these substances in the ash of the plants, they have concluded that the soil cannot supply them in sufficient quantity. I could bring forward a great number of experiments, tried at my suggestion upon various soils, which would prove that alkaline manures were quite incompetent to remedy the exhaustion from which they suffered; but the general practice of the best agriculturists is more convincing than a thousand such experiments. Take the case of a soil which has been in the hands of a farmer who has removed from his land successive grain crops, and who has also sold part of his straw and hay, bringing back perhaps a little soot, or some light manure. This system would exhaust the soil of its alkalies to the greatest extent possible. Should it then come into the possession of a man of capital and experience, he may in a few years bring it into high condition without imparting to it a pound

of potash or soda, though the course he would probably adopt would indirectly increase the available sources of those substances.

The quantity of alkalies taken up from the soil by a crop of turnips is very great, and yet the artificial manures most commonly applied to grow these turnips contain but little and often no alkalies whatever. As long as bone-dust, superphosphate of lime, or guano, will produce a good crop of turnips, the farmer need be under no apprehension of his soil being destitute of alkalies. The only mineral which, under a proper system of agriculture, it is necessary to restore directly to the soil, is phosphate of lime. Where large breeding flocks are kept, the phosphate of lime exported in the bone of the animal is very great, and many soils are incapable of yielding this in sufficient quantity. Previously to the introduction of guano into this country, large quantities of nitrate of potass and soda were employed as manures. Their value was, by many persons, attributed to the alkalies they contained; but the almost universal substitution of guano shows very clearly that the potash and soda were not the constituents to which their effects were due. At one time I thought it probable that the silicates of potash or soda might prove of some service to grain plants, but repeated experiments with these substances have caused me to alter my opinion.

The strength of the straw in grain crops seems to depend upon a healthy condition of the plant, arising from a properly balanced supply of mineral and organic constituents, as well as upon the influence of certain physical conditions of soil, especially during the early stages of growth. Thick sowing, a cold wet summer, and excess of ammonia, are all injurious to the strength of straw.

Unless straw is sold, there is a constant accumulation of silicate of potash upon farms, arising from the annual decomposition of the soil; and upon some farms the production of straw increases to an injurious extent. It is a common opinion, that artificial manures act as stimulants, and that the continual employment of them tends to exhaust the soil. This idea is to a certain extent correct; and where they are used injudiciously (as, for instance, when a mineral manure is employed upon corn crops) it would lead to such a result. But if they are employed to increase those crops which are consumed upon the farm, such as turnips and clover, they then become valuable aids to the natural resources of the farmer.

To obtain agricultural crops of clover, tares, and turnips, purely artificial conditions of growth, quite at variance with the natural tendency of the plant, are induced: and it is well known that the crop of clover which will yield the most hay is by no

means that which would be selected for seed. These conditions are secured by an artificial supply of certain elements favouring the desired determinations of the plant ; and therefore artificial manures may for such purpose be employed with advantage.

If grain crops, as I have endeavoured to show, can be grown at a cheaper rate by the production of meat, than by the direct action of artificial manures, the propriety of adopting the former course to its full extent becomes simply a question of capital. It would require five times as much capital to produce the same amount of corn by means of stock as could be produced by artificial manures. It is the same with the manufacturer who employs a high-pressure or a double-cylinder engine ; with the former his capital invested is small, but the interest paid upon it, by the daily consumption of fuel, is very great, while with the latter his invested capital is large, and his daily interest comparatively small. The want of sufficient capital among so large a portion of our agriculturists cannot be sufficiently deplored in a national point of view. They imagine that the greater extent of land they can farm with a limited capital, the greater will be the interest obtained for it ; by which means the amount of labour employed is reduced to the smallest possible extent. High prices have hitherto allowed a system of agriculture to be pursued, by which little more than the natural produce is obtained from the soil. But if the average price of corn should ever be reduced to the standard of other countries, a reduction of rent must take place equivalent to this diminution, or the decrease in the value of corn must be balanced by an increased average produced in the soil.

J. B. Lawes.

Rothamsted.

XII.—*On the Farming of Suffolk.* By Hugh Raynbird.

Prize Report.

In offering this report on the farming of Suffolk, I would first observe that there are various causes which render it difficult to communicate much that has not already come before the agricultural world, though at the same time it makes the task of writing a Report easier. 1st. The voluminous writings of Arthur Young refer in a great measure to the county in which he resided. 2nd. All the neighbouring counties, Norfolk, Essex, and Cambridge, have already been described in the Society's Journal. The cultivation of our heavy land resembles that of the adjoining parts of these counties, of our western light land that of the light land of Norfolk, and of our fens that of the fens of Cambridgeshire. Norfolk and Suffolk may be considered nearly as one county, as they are generally named together; and indeed Mr. Bacon, in his report of Norfolk, has forestalled much that relates to Suffolk in his able account of the celebrated Suffolk machine-makers, Ransome, Garrett, and Smyth. 3rd. Many of our countrymen have already described several of the Suffolk practices in the Society's Journal, as Sir Henry Bunbury, on Cottage Allotments; Hill, Essays on Cottages and on Draining; Rodwell, on Mowing Wheat and Italian Ryegrass; Raynbird, on Measure Work and the Cultivation of Beet; Burroughes, White Mustard; Dobedo, Fatting Cattle; Peirson, on Burning Soil; and Poppy, in various publications on Mangold Wurzel, Burning Clay, &c. These gentlemen have so recently written on the subjects here named, that it would be but a repetition to enter very minutely into them, except where they have omitted giving a full description.

Extent.—Suffolk presents a level and well-watered surface of a crescent-like form. Its length from E. to W. about 48 miles, and breadth from N. to S. nearly 30 miles. Its extent is reckoned at 918,760 acres.

It is estimated that there are about 46,000 acres of rich loam, 80,000 acres of marsh and fen land, 450,000 acres of a heavy loam or clay, 250,000 of sand of various qualities.

The climate is one of the driest in the kingdom, hence the fine quality of grain grown; but the turnip crop frequently becomes mildewed when early sown, from a continuance of dry weather. We have many county meteorologists, from whose observations we may both tell the past seasons, what kind of weather we are to expect in general, and compare the climate as to drought, rain, frost, &c., with other parts of England.

1. *The character of the Soils of the County.*

In describing the soils of Suffolk, I have followed the example of Arthur Young in giving a map of the soils, believing that this will give a better idea of the distribution of the several varieties of land than any other method. Though this plan will only be an approximation to the truth, as variations are to be found in every part, yet the surface soil of Suffolk is perhaps as clearly defined as that of any other county possessing an equal extent of land with the same distinct variations in the soil.

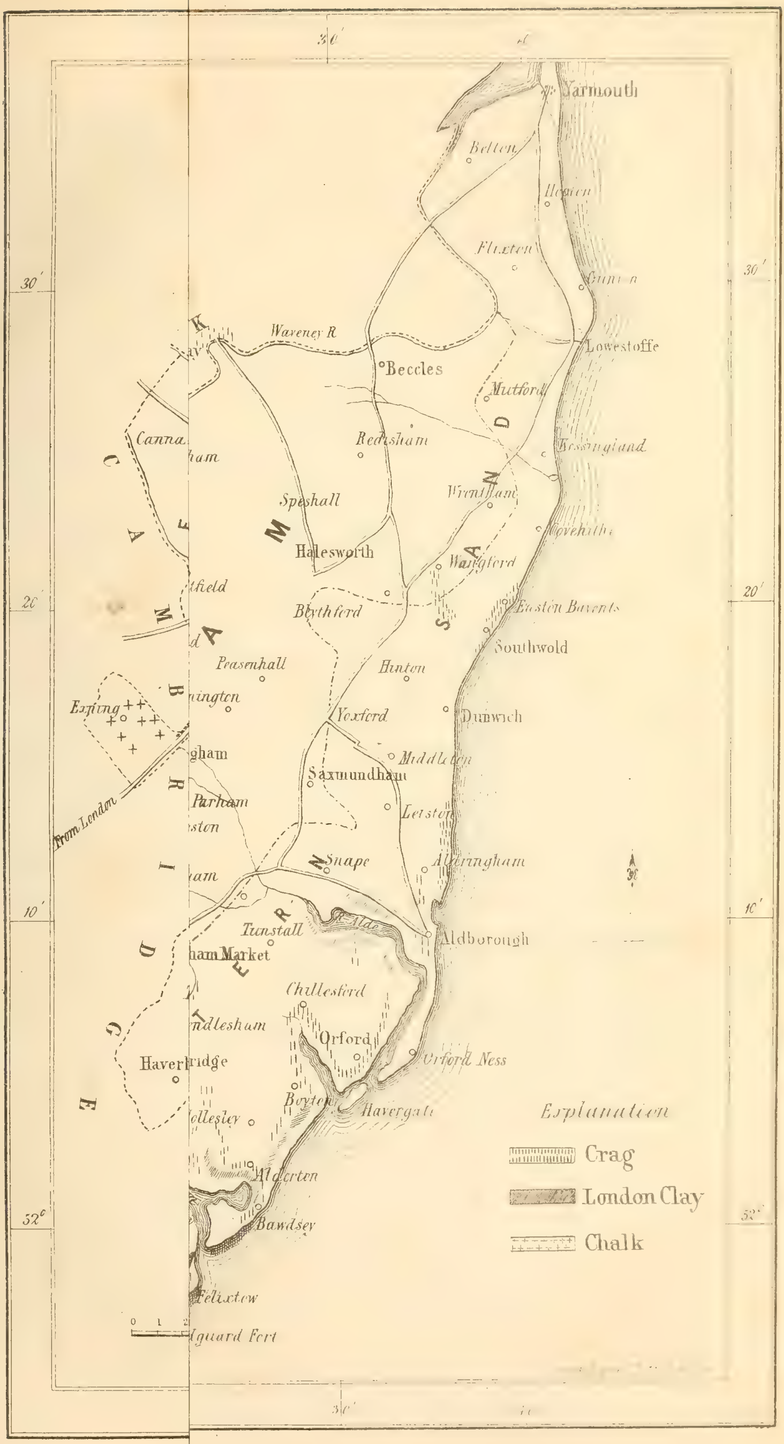
If a correct geological map, showing the substrata of the county, had been added to this Report, it would have been more satisfactory to the scientific agriculturist; but as a great part of Suffolk is covered by shallow deposits of sand, gravel, clay, and loam, a geological map would not have exhibited the agricultural relations of the county more faithfully than the annexed sketch of the surface soil. The latter will, at least, give an idea as to the kind of farming a stranger may expect to see in any particular locality. And the chalk and crag pits being marked, will be a slight index to the subsoil.

It will be seen on the map that there are 5 distinct divisions, each of which demands a description.

1. Strong loam. Woodlands.
2. Eastern sand. Sandlings.
3. Western sand. Fieldings.
4. Rich loam.
5. Fen.

S. Woodward, Esq., has favoured me with the following information on the geological character of the soil:—

"The lowest stratum in the county is chalk, which exists at a greater or less depth beneath every part of it, except the small corner occupied by the fens, which rest either on green sand or Kimmeridge clay. Proceeding westward from Bury along the road to Newmarket, the chalk either appears on the surface, or is covered with a very moderate thickness of sand, and throughout the whole of the western sand district, the chalk is at no very great depth from the surface. The old warrens used to indicate the locality of beds of sand. Even at Botesdale, east of Bury, there are chalk pits. Further east the chalk inclines rapidly, and is lost sight of beneath several hundred feet of clay, sand, and gravel, except in some places, for instance N. of Ipswich, where the turnpike-road cuts through it; and there are chalk-pits at Debenham and Stowmarket. In the neighbourhood of the valleys of E. Suffolk the chalk is probably never far from the surface, as these are valleys of elevation. The London clay makes its last appearance northwards in East Suffolk; the base of the sea cliff at Felixstow consists of a dark clay, containing the characteristic fossils of the London clay; it extends inwards as far as Hadleigh, but is buried beneath newer clays and gra-



Yarmouth
Belton
Flixton
Waveney R.
Lowestoffe
Beccles
Mutford
Redisham
Kessingland
Wrentham
Speshall
Halesworth
Covehithe
Wangford
Blythford
Easton Bavents
Southwold
Peasenhall
Hinton
Dunwich
Yoxford
Middleton
Saxmundham
Parham
Leiston
Snape
Aldringham
Aldborough
Tunstall
Chillesford
Orford
Orford Ness
Boyton
Havergate
Alderton
Bawdsey
Felixtow
From London
Explanation
Crag
London Clay
Chalk


MAP OF
THE SOIL OF
SUFFOLK
Corrected from the Map made by
A Young in 1797
Yarmouth
Southwold
Framlingham
Stowmarket
Hadleigh
Harwich
Haverhill
Wickham Brook
Ixworth
Rushbrook
Brandeston
Laxfield
Debach
Bucklesham
Chillesford
Dunwich
Lavenham
Felsham
Boxford
Capdock
Cheveley
Clare
Stanstead
Bildeston
Cowlinge
Thurlow
Crag
London Clay
Chalk
Miles
from Greenwich

vels. The next stratum above the London clay, the Crag, is also limited in extent. It is a ferruginous sand, full of shells, and was once much used as a dressing for clay lands. At Walton on the Naze it is about two yards thick, and abounds with spiral univalves, sharks' teeth, &c. At Harwich it is scarcely discoverable, and at Felixstow it is reduced to a shingle bed, consisting chiefly of nodules containing 56 per cent. of phosphate of lime. Mr. Lawes had several tons of this ground up for manure. At Aldborough and Orford the crag becomes coralline, and is often a complete coral reef. At Woodbridge there is the red crag, with the same shells as at Walton; and near Southwold, the newest beds of crag containing teeth of the mastodon and elephant, and shells of mollusks still living on our coast. Between Southwold and Yarmouth the cliff consists of sand and gravel, with a bed of clay 'till,' sometimes forming their base, and again rising up to the middle or to the surface. The 'till' is seldom a clay impervious to water, it usually contains a great quantity of chalk; in other parts it consists entirely of the wreck of the Kimmeridge clay, oolites, &c., which once filled up the present 'level of the fens' with a thousand feet of strata."

Heavy Land or Strong Loam.—It will be seen by the map that this district takes in the great body of the county, extending from the S. to the N. extremity, and from the S.W. nearly to the N.E. corner; this throughout its whole extent consists chiefly of a clayey loam on a clayey or marly subsoil, in some places the soil takes more the character of clay, in others that of a loam. The variations from this are but slight. On referring to the map, it will be seen that chalk pits are dotted in various places—wherever they occur, the soil in their immediate vicinity of course partakes of a chalky character in a greater or less degree. About Weybread and Mendham the soil in some places is of a sandy nature. Along the course of the Waveney are rich grazing marshes composed of alluvial soil. The low hills that border the Waveney have frequently stiff clay on their summits, and light sandy land in the bottoms. Throughout the "heavy lands," as this is locally termed in contradistinction to the "light lands," or sandy districts, the soil bordering on the rivers is the richest, the most easily cultivated, and therefore the best land for the farmer, and to be preferred to the retentive soil that generally occurs.

Eastern Sands.—The tract of land on the eastern side of the county, bordering on the sea-coast, is more or less of a sandy nature, a great portion of which is highly cultivated, though in some parts the soil is of a very inferior description, sometimes a blowing sand, and still lying almost waste. A large extent of wild heath land is to be seen in travelling from Wickham-Market to Orford; the road passes over Tunstall heath, which has every appearance of barrenness. And again, the country between Orford and Woodbridge, and a large portion of Wilford Hundred, the crops during my ride through that part in the summer gave

ample evidence of a sterility which the existence of so extensive a tract of waste land as Boyton, Iken, Chillesford, Sutton, and Hollesley Heaths sufficiently corroborated. The heath land from Sutton to the bridge over the Deben,* near Woodbridge, appears, from the luxuriant growth of the ferns and whins, to be of a better quality.

There is so great a difference in the quality of the land in the eastern sand district, that I have the authority of a gentleman, who is one of the largest tenant-farmers in Suffolk, in stating that land may be found on nearly every farm, the value of which to rent will vary from 5*s.* to 28*s.* per acre. In some parts of this district the sand lies to a considerable depth; and when this is the case it precludes any improvement by the admixture of soils, unless at a very great cost. In other parts the subsoil is chalk, marl, or crag, and here the great means of the improvement of the texture of the sandy soils is to be found. The admixture of the subsoil with the surface has more than anything else contributed to place the cultivation of the light lands of Norfolk and Suffolk in the first rank in the scale of farming.

On the whole line of sea-coast there are tracts of salt marshes, varying in value from 5*s.* to 25*s.* per acre, as they are more or less subject to the influence of the tides. A great portion of the marsh land is subject to inundation when the tides happen to be unusually high. This may not occur for several years; but when it does, it is productive of great injury to the marshes for many years.

Western Sand District.—This tract of country takes in some of the worst description of soil, much of it being a blowing sand on a subsoil of chalk or chalky clay (in some places† the chalk appears at the surface) and is never at a great depth. In the report of Arthur Young, it is mentioned as abounding in rabbit-warrens and sheep-walks; a great proportion of these have been broken up, and the district is altogether much improved, though some of the land is so sterile, as to almost defy all attempts to bring it into a productive state. The worst description of soil occurs at Thetford, Brandon, Wangford, Lakenheath, Icklingham, Cavenham, and West Stow. The S.E. portion of this division, in the neighbourhood of Bury, is of rather a better staple, the soil being a gravelly loam, and in some places the characters of heavy and light land become intermingled.

Rich Loam.—This comprehends the greater part of Colneis and Samford Hundreds, the lands of which may be considered the best in the county; and it cannot be better described than in

* Wilford Bridge.

† The chalk appears at the surface at Barnham, Thetford, Brandon, Eriswell, Newmarket, and to a less extent at many other places.

the words of Arthur Young:—"From the River Deben crossing the Orwell, in a line some miles broad to the north of the River Stour, to Stratford and Higham, there is a vein of friable putrid vegetable mould, more inclined to sand than to clay, which is of extraordinary fertility; the best is at Walton, Trimley, and Felixstow, where, for depth and richness, much of it can scarcely be exceeded by other soil to be found in others parts of the county, and would rank high among the best in England."

The last district, occupying the extreme N.W. corner, is composed of fen land, the peat overlaying the clay, though on the borders of the fens the subsoil is often sand. A narrow strip of peaty soil extends along the banks of the River Ouse, and also along those of the Lark; this is chiefly meadow land, generally producing a very inferior description of grass.

This small tract of peat land has perhaps undergone as much improvement as any other part of the county. Arthur Young mentions the fens as being partly under water; they are now well drained by powerful steam-engines. By the application of bones, and by the process of claying, very abundant crops are produced, though the quality of the grain is not equal to that of the adjoining light land. In the time of Arthur Young the staple produce was oats and coleseed; but the application of clay has completely changed the nature of the soil, and on the best cultivated farms a four-course system is adopted of—1st year, fallow for coleseed drilled with bones and the crop fed off by sheep; 2nd, oats and sometimes barley; 3rd, layer or beans; 4th, wheat. Fen-wheat is considered a good change of seed for light land. Timothy grass (*Phleum pratense*) has of late years been grown on the fen farms, and is considered an acquisition; it is either sown by itself and allowed to lay down three or four years, or it is sown with clover; for the latter purpose it must be well suited to this kind of soil.

One cause of the improvement of the fens is that many of the large light-land farmers are also holders of fen farms, and, being men of education and capital, have raised the cultivation of the soil.

2.—*The Management of the Land on the Various Soils.*

In describing the farming practices of the different soils I shall divide the county into two divisions—the heavy land, including the greater portion of the county; and the light land, which may be subdivided into the eastern maritime sandy districts or sandlings, and the north-west sandy districts or fieldings. The fen district occupying the north-west corner of the county is of so small an extent, and the similar soil of Cambridgeshire has been so lately described by Mr. Jonas, besides being a subject

for an essay for the ensuing year, that it can hardly demand much attention in this Report. The farms in the heavy land district seldom exceed 300 acres in extent; they are generally much smaller, and many are found from 30 to 50 acres. There are some large farmers (*i. e.* those holding several farms) but few large farms, the land being subdivided, and many small landowners farming their own estates. The farms on the light land are much larger, and vary from 300 to 1500 acres.

Most writers on the farming of Suffolk have found fault with four practices :—

1. Bad management of grass-land, and bad system of making hay.

2. Want of irrigation, notwithstanding the number of streams suitable for the purpose.

3. Heavy carts and waggons.

4. Inconvenient farm-buildings and large barns ; and a stranger travelling through the county would add a 5th, in the number of hedges and *hedge-row trees.*

These are, however, no new complaints; for Arthur Young condemns them all. However, the 1st and 2nd objection is in process of removal by the pasture-land being at the present time in the course of conversion into arable land. The 4th and 5th are faults for which the owners of the soil are rather to be blamed than the occupiers and cultivators ; but, though improvement has been slow in these, yet it has made ample strides in those practices, which at the time Arthur Young wrote his report were deemed much nearer perfection. Among the practices most worthy of notice are—

1. The system of *thorough draining,* which there is ample evidence to prove has been practised for more than a century.

2. The system of *tillage,*—ploughing, harrowing, rolling, drilling, horse-hoeing, &c., adopted on heavy land, by which the injurious effects of treading is *avoided altogether* in these operations.

3. The universal system of ploughing with *two horses,* however stiff the soil may be ; and, as the Suffolk poet says,

> " No wheels support the diving pointed share,
> No groaning ox is doom'd to labour there,
> No *helpmates* teach the docile steed his road,
> Alike unknown the *plough-boy* and his goad ;
> But, unassisted through each toilsome day,
> With smiling brow the ploughman cleaves his way."
>
> BLOOMFIELD's *Farmer's Boy,* 1798.

4. The practice of sowing spring crops on a *stale furrow,* the action of the elements during the winter being found more effectual in securing a fine tilth than spring cultivation.

5. The cultivation of *mangel wurzel.*
6. The *admixture* of the *subsoil* with the *surface,* by claying and marling light land.
7. The cultivation of roots, particularly *carrots,* on light land.
8. The *manufacture* and *use* of agricultural implements.
9. The breed of *farm-horses.*

Having thus enumerated the most striking features in the farming of the county, I shall proceed to give a description in detail of the

Management of the Heavy Land.

I shall first treat of the heavy land district, which is the most extensive, as will be seen by reference to the map; and from its extent, and the general superior quality of the land, it is also the most important. Draining and the peculiar system of drill husbandry have rendered it one of the finest corn districts in England; the increased cultivation of green and root crops, especially mangold-wurzel, is rapidly contributing to place the farmers among the largest graziers of fat sheep and cattle. A great portion (the middle and northern part) was in the time of Arthur Young the seat of the celebrated Suffolk dairies; these have nearly disappeared: it is said that there is not a tenth part of the number of cows now kept. At that time the dairy farms consisted of grass land; they are now chiefly arable, and what pasture remains is rapidly being broken up wherever permission is given to do so.

The low price of butter and cheese, caused by the competition with Ireland and Holland, and a reason which I have heard advanced by more than one farmer, viz. the difficulty of procuring dairy servants, have mainly contributed to the disuse of the dairy system. But when we consider it is now asserted by many who were themselves dairy farmers that one-third more is paid for rent, two-thirds more for tithes, and double the amount for labour than was paid under the dairy management of the latter part of the eighteenth century, it shows at once that the improvement in the farming has been very great, particularly as this is a thickly inhabited agricultural district, where nearly the entire labouring population has to depend on the farmer for its subsistence.

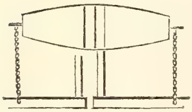
Hemp was grown in the time of Arthur Young to some extent in that part of the county between Eye and Beccles, but its cultivation is very nearly discontinued.

The present system of drilling was in its infancy when Arthur Young wrote his report; it is now become general, and on the soil adjoining (the light land district) it is probably carried too far, for here light sandy land is sometimes seen ploughed in narrow stetches, with deep furrows between them; this must occasion a loss as nothing grows in the furrows, and also cause injury by the deep furrows drawing the water from the soil.

The land of this district being ploughed with great exactness in 10 or 12 furrow stetches ($7\frac{1}{2}$ feet and 9 feet), the drills are constructed to sow either a whole or half a stetch at once, leaving for wheat about 1 foot in the furrows unsown. A whole drill (one that covers a stetch) is drawn by four horses (two in each furrow) for wheat sowing, and three for drilling spring corn, though six horses are used in the very large drills that cover a 12-furrow stetch. Half drills, for sowing half a stetch at once, are the most generally used for 12-furrow work; in these the shafts are quartered, so that the horses (usually two) walk in the furrow followed by one wheel, the other wheel working upon the top of the stetch; but in wet weather the path made by this wheel is considered to be injurious, particularly if the wheel runs upon a row of seed that has already been deposited: but to prevent this, the half drills are fitted with a slip axle which admits of being lengthened out that the wheels can be adjusted to go in the other furrow, and thus do the work without any injury either from the treading of the horses or the tracks of the wheels on the land.

The other implements, such as harrows, rolls, horse-hoes (where used), are also constructed so as exactly to fit the stetches, and the horses walk in the furrows. Horse-hoes, which are used in some parts, though not in all, are fitted with adjusting axles similar to the drills. The old common horse-hoe is used by some farmers for horse-hoeing wheat, barley, beans, and roots; and with such exactness is it managed that 6 and 7-inch rows are often hoed without injury to the crop.

Barley and other light rollers are made double, and cover two half-stetches, the horse walking in the furrow; a small roller or "follower," as it is termed, for rolling the furrow, is attached to the hinder part of the rolls by chains or by a frame of wood thus.



The shafts of the double roll admit of being altered, so that one roller may be used by itself; or, when removed from one field to another, one roller can be conveniently placed before the other. Heavy rollers have the shafts quartered or placed on one side.

Having thus described some of the principal features of this district, I shall proceed to consider the rotation and manner of cultivation pursued. In the course of cropping there is much variation, particularly among the smaller farmers; but on the largest estates and throughout all the best cultivated farms the course of cropping is:—

1. Fallow: either clean fallow, tares, beet, or turnips.
2. Barley.
3. Half clover; half beans or peas; alternately.
4. Wheat.

This may be taken as the general course. The modifications which are occasionally made by good farmers are:—In the first year having all long fallow on strong land, or all roots, or growing rye-grass or trefoil for spring feed, and then breaking up for fallow. In the second year the growing wheat after beet, and sometimes after turnips, instead of barley. In the third year, the growing tares instead of beans, and, what has lately been introduced, the cultivation of Italian rye-grass instead of clover, by which the repetition of the latter is removed from eight to twelve years. And the growing of oats on freshly broken-up land, and, to a small extent, in lieu of other white-straw crops for the purpose of home consumption.

Variations, the usefulness of which is much to be questioned, are the taking a third crop, as it is called, which is oats after wheat and then fallow; the growing white-straw crops in succession on freshly broken-up pasture: many instances are known of farmers ploughing up a piece of sward, taking first coleseed, and then wheat for three years running. Such scourging as this is much to be reprobated, and is productive of considerable injury to the land, the farmer, and the nation at large; such deviations as growing two white-straw crops in succession ought never to be sanctioned, though deviations from any rotation, however good, may frequently be made with propriety by the judicious cultivator to suit circumstances. The constant recurrence of one monotonous round of cropping must after a time end in the failure, to a certain extent, of one or more of the plants grown; and the farmer being bound to this, is unable to exercise his judgment in growing those crops which will command the highest price in the market.

The four-course rotation, as adopted on the heavy land of Suffolk, is perhaps better suited to this description of land than most others; it is certainly better than any other that has yet been tried.

The recurrence on the average of a long fallow once in eight years is considered absolutely necessary by the best farmers for the cleaning and amelioration of stiff land by repeated ploughings and pulverizations; and there are a few who consider a clean fallow is necessary every four years. The failure of the clover is generally prevented by its recurrence only once in eight years. The growing of peas and beans to be followed by wheat may be objected to by some who farm in a distant part of the country, but without much cause; the deep hoeings and clean cultivation of the pulse makes it a good preparation for wheat—as an instance of which, one farmer has grown wheat and beans alternately for twenty years without any perceptible deterioration of the annual crop, in a part of the county where the four-

course system is usually practised—while the system of beans and wheat alternately, with a fallow every five years, is adopted in a small extent of the county where the soil rests on the London clay.

1st Year, Fallow.—The number of ploughings to make a clean fallow is 5, sometimes 6, viz.:—1, ploughing in the stubble; 2, turning back the furrows; 3 and 4, ploughed overthwart (across the previous ploughings) in broad stetches usually 2 rods wide, 5 stetched up for turnips, or if long fallow, for barley; some give the stetches another ploughing before laying the land up for the winter.

The first ploughing of a clean fallow is given generally previous to the winter setting in, though there are some who advocate the practice that was common thirty or forty years ago, of allowing the land intended for long fallow to lie unploughed till the spring, alleging that the land works much better. This is entirely out of the question for roots, but there are feasible reasons to give for its being adopted, it allows more time for the preparation of the other fields intended for roots; and it does not spoil the early partridge shooting, as there is no occasion for the immediate removal of the stubble—the latter is not of much importance to the tenant, though it certainly is to a few of the owners of heavy land. Much, however, depends on the season; wet land ploughed up, and then exposed to an open and rainy winter, will most likely work badly in the spring, and probably much worse than if allowed to remain whole. The advocates of breaking up fallows in the spring will certainly allow that there is advantage in exposing land to the frost, for the same farmers who objected to the autumn ploughings of long fallows yet advocated the autumn and winter preparation for roots.

Harrowings and rollings intervene between the ploughings, though it is considered by some farmers that too many harrowings are frequently given: the couch-grass and rubbish is got out of the land after the second ploughing, it is brought to the surface by harrowing and picking, and then burnt. After the second ploughing overthwart, a marker of the exact width of the stetches is sometimes used previous to ploughing the land in stetches—this is a bar of wood or iron having two coulters at the required width fixed behind a pair of wheels and shafts, usually those of the horse-rake; this is drawn over the land, and leaves straight marks for the guidance of the ploughman. The land being laid up for the winter before Christmas, the barley is drilled upon the earth which has been pulverized by the winter frosts without any other preparation than a light harrowing or scarifying.

As a rule, no advantage is ever derived from ploughing fallows in wet weather, and very seldom from sowing the seed, whether

of turnips, beet, or barley, directly after the plough. One of the greatest difficulties attending the cultivation of roots on heavy land is the getting the land into sufficient tilth; if the land is ploughed when wet, the furrows harden into one mass, and if very dry it breaks up into clods. By spring-ploughing there is every chance of producing clods instead of mould, and hence the advantage of preparing land intended for roots in the winter or autumn. The ridge cultivation, so well adapted for the removal of roots from a heavy soil, cannot be practised with the certainty of securing a crop when the land is ploughed in the spring; on account of the difficulty of bringing the land into good tilth under the system of five ploughings, seed sown on a ridge of clods is less likely to vegetate than when sown on the flat stetch, hence the latter method has until lately been generally adopted.

When tares are grown on the fallow, manure is generally applied at the rate of from fourteen to sixteen loads per acre, the land ploughed once, and the seed drilled at the rate of from ten to twelve pecks per acre; half a bushel of oats or rye is frequently added; when sown late in the season the quantity of seed per acre is increased; the purposes to which the tares are chiefly applied are for soiling the horses during the summer. Where sheep are kept tares are sometimes fed off, either with hurdles on the land or mown and carried on a pasture; when hurdled, the tares are generally mown before given to the sheep. A few farmers sow coleseed or turnips after the tares. A heavy-land farmer who has practised the system of tare-husbandry for sheep has given it up, having found that it is impossible to keep his land clean; he allows that a good crop of tares has a cleaning effect on the land, though he considers a bad crop to have quite a contrary effect: by substituting a long fallow he is able to keep his land clean, though he does not grow a heavier barley crop.

Tares are by some given to grazing bullocks; I found one farmer was feeding on tares, beet, bean and barley meal, and cake, in June, 1846.

Italian rye-grass and trefoil have of late been grown by farmers who keep sheep for the purpose of affording spring feed; they are sown on a wheat stubble; after feeding off in the spring the land is broken up and sown with turnips or summer fallowed.

Turnips, &c.—The practice of reaping wheat still prevails, and consequently the stubble has to be cleared off the land previously to its being ploughed up: this is undoubtedly a loss of time, particularly on those lands intended for mangel or swedes; but the question is, how are we to obviate this? The mowing such heavy crops as are generally grown is not likely to be practised in every district, but still mowing, bagging, or reaping low will further the preparation of the land for beet and swedes, as there

is then time to plough the land before wheat-sowing; this is an advantage not to be despised, as it is one move towards securing a crop. Several methods are adopted in the cultivation of roots, each of which has its advantages; they will therefore demand a separate description. I shall first consider the old method, which is still generally adopted for white turnips, and frequently for swedes and beet. In this the fallow is made in the usual manner, but in time for the season of turnip-sowing. Muck is applied by some; by others a dressing of burnt earth, and on some land artificial manure (particularly where the crop is intended to be folded with sheep), such as rape-dust, bones, and guano; white turnips are drilled from 14 to 18 inches apart, and beet at proportionably wider intervals; the turnips are hand-hoed at a cost of from 6*s*. to 7*s*. per acre. The late period at which turnips are usually sown is the great objection to their success on heavy land, which is not suited to the feeding with sheep; for if late sown they remain on the land through the winter, and the removing them day after day at a cart-load a time in any weather must be productive of injury to the land; by early sowing, the roots may be removed from the land and stored early in the season with comparatively little injury.

The early season at which beet is sown, and the little injury it causes when carted from the soil, are the merits to which it owes its extended cultivation; there are few farmers in the heavy-land district of Suffolk of 100 acres that do not grow on an average four or five acres of this valuable root. The more the turnip-husbandry approaches that of beet in respect to the early sowing and removal from the soil, the sooner will it arrive at perfection on these heavy soils. White turnips, which are apparently cultivated to the greatest extent, should give place to beet and swedes, both are superior in their feeding qualities, as well as what gives them a *greater value*, their *property of keeping* when removed at an early season from the land and stored in a convenient situation.

Beet.—I shall now proceed to give a description of the cultivation of beet, which has been introduced about thirty years, during which time its cultivation has been continually on the increase; and it may be truly said that it is a crop which has tended more than any other to improve the heavy land of Suffolk, and I may with confidence assert that its cultivation is one of the greatest improvements that has been introduced since the report of A. Young in 1804. It has filled up a blank which used to occur in the feeding of sheep and cattle on heavy land, the *providing spring food.*

Land intended for beet is ploughed immediately after harvest, and the fallow made in the usual manner of ploughing the

stubble in, ploughing back, thwarting twice, but instead of the fifth ploughing or stetching up, the land is ploughed in ridges from 27 to 36 inches wide with the common plough, a dressing of from 16 to 20 chaldron-loads of farm-yard manure is applied; some use muck fresh from the yard, others compost dung; the manure is then covered in by splitting the ridges, the land rolled, and the seed, from 5 lbs. to 6 lbs. per acre, is either dibbled by hand or drilled at the latter end of April or beginning of May.

Before hoeing, a plough without a breast and fitted with a broad share, or a shim with a share and side-hoes, is used between the drills, and good cultivators repeat this several times throughout the summer; the mangel is generally hand-hoed three times, the first hoeing costs 3*s.* 6*d.*, the plants being singled by children after the hoer; the other hoeings cost about 2*s.* 6*d.* per acre: it is found that the deeper the land is cut with the hoe, and the more the soil is pulled away from the bulbs, the less liable they are to grow with long fibres and fangs. The varieties chiefly cultivated are the long red; the red and yellow globe varieties have lately been introduced. Horn beet, a variety of the long red, is preferred by some.

Beet grown on the stetch (usually four rows on ten-furrow work) has more roots than when grown on the ridge; this is attributed to the earth not being so much pulled away by the hoe. Mangel is harvested about the latter end of October or beginning of November; the pulling and stripping the leaves is often done by women and children at so small a price as from 3*s.* 6*d.* to 4*s.* per acre; they are then carted off the land and laid on a headland, or in a convenient place in a ridge-like heap about six feet wide and four feet high; this is covered with straw or haulm, and then with a layer of earth taken from the side of the heap; the top or ridge of the heap is generally left uncovered with earth; some take the precaution of adding another layer of haulm on the outside of the mould. In May the roots begin to shoot, and are then likely to heat and rot; to prevent this the heap is broken up, the shoots rubbed off, and the roots laid in a barn or outbuilding. It is obvious that by the bulbs growing they will lose a portion of their nutriment; it is, therefore, folly to allow them to grow in the heap. Some do not pull down the heap, but merely remove the roots to the cattle as wanted, and yet find that they will keep through the summer without decaying, but the heap should not be made very large, and the roots should be dry when laid up.

If wet weather occurs at the time of pulling, different methods are practised to prevent injury to the land by carting; some pull the mangel and cover them with the leaves, and allow them to remain in that state till dry weather comes for carting off.

Another plan is to remove the roots entirely by manual labour; and I have the authority of Mr. A. Gissing, of Stradbroke, to state that in a wet season he got his beet off a ten-acre field without the aid of horses, at a cost of 9*s.* per acre; women and children pulled the beet, while men carried the roots in baskets or wheeled them in barrows to clamps on the side of the field. Three clamps were made on one side of the field and three on the other. The people employed made good earnings.

Besides the employment of the labourer and his family, and the absence of injury to the land from the treading of horses, this practice, to judge from the above statement, appears to be quite as cheap as using horses and carts.

In seasons dry enough for carting off the beet, wheat is grown thereafter to a considerable extent instead of barley, and produces a superior quality of sample. Good crops of barley are generally grown after beet; as a preparation the leaves are ploughed in; it has been found that the barley-crop is inferior where the leaves have been carted off.

Swedes are frequently cultivated on the ridge in the same manner as beet, the seed being sown about the beginning of June; they do best on the ridge in a wet season, but in a dry one the ridges being cloddy and dry, the swedes do not grow well. Those who fat cattle cart the crop off the land before Christmas (November and December), and store in heaps near the fatting-yards or along a headland in a stubble-field; some store them in a similar manner to beet, the heap rather smaller, but covered with straw only; some lay them in heaps between hurdles and then thatch with straw; others only cover with straw at first, as the swedes are apt to heat, but about three weeks after cover with earth: in this manner swedes keep sound till the spring. How much better this practice of carting roots from the soil and storing them, than carting a load of roots from the field daily, which are either covered with dirt or in a frozen state! By this tardy management the farmer's sheep and cattle are badly supplied with food, and his barley crop spoilt on account of the late time of sowing.

There is yet another way of managing heavy land for roots, which is coming into notice and appears to have great advantages, particularly as it does away with spring ploughing, and with another injury so often complained of, that of carting the manure on wet land in the spring.

The stubble is ploughed up early in autumn, and the land ridged in about 30-inch ridges (these are sometimes turned back), and then a dressing of farm-yard manure applied, spread, and covered in by splitting the ridges; in these operations the common plough is used. The land now lies exposed through

the winter to the action of the frost, and no more ploughing is given till the seed is drilled in the spring. The ridges are made across the direction the land is stetched up, so that when ploughing for the following year barley the furrows are laid in a contrary direction to the ridges of the root-crop ; by this means the manure applied to the roots becomes equally distributed in the soil, and the barley is a level crop and ripens altogether, which would not be the case if the land was ploughed in the direction of the ridges.

This is undoubtedly the simplest and most effective way of securing a fine tilth for the seed. If weeds vegetate during the winter, they are destroyed by using the scuffler, or horse-hoe, over the land before sowing, and if considered necessary, the ridges are then moulded up with a small double-breasted plough. In that part of the county where this system is adopted, the mangel and swede seed is dibbled: one man will dibble about an acre in a day ; the plants are first singled by hand and then hoed deeply. The shim, or horse-hoe, is used frequently between the ridges. The Rev. Copinger Hill, who adopts and advocates this system, has kindly favoured me with the following memoranda respecting the beet crop which he has grown under this system ; the average of his crops is 20 tons per acre.

Memorandum of mangel crop, 1843; crop 20 tons per acre. Expenses of pulling up, stripping leaves, drawing, earthing up, and bringing haulm per ton, $7\frac{1}{5}d.$

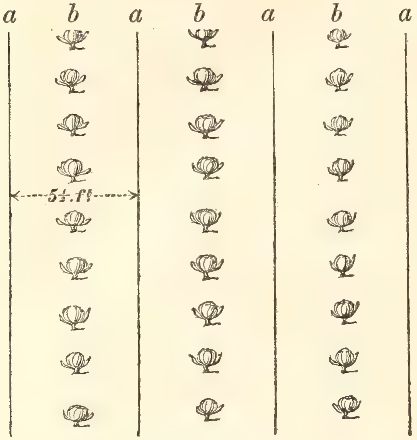
Expenses of clearing mangel in 1841 :—

	s.	*d.*
Pulling, Carting, and Stacking 18 tons per acre	11	0
Bringing haulm for two coverings . . .	2	0
Earthing up	3	6
Total .	16	6

Carrots.—White Belgian carrots are grown by a few farmers: the manner of cultivation is drilling on the ridge or flat without manure, the seed being rubbed and mixed with sand to ensure delivery from the drill. Oats are often sown with the seed to show the rows, so that the hand and horse hoe can be used.

The subject of growing roots as a fallow crop is of so much importance that, at the risk of being considered prolix, I shall introduce the following description of growing roots, &c., as practised by Mr. J. C. Downing, of Earl Soham, who advocates the system of ploughing heavy land in 8-furrow stetches, using a whole drill (one that covers a stetch at one movement, the two wheels working in the furrows), and argues that roots may be carted off the land at this width of stetch without injury to the soil, as the stetch exactly fits the width of the wheels, and the

horse may be made to walk in the furrow by quartering the shafts of the cart.



Cabbages are not very generally grown, but Mr. Downing's plan appears to be advantageous, as it secures both a green crop and the benefits of a long fallow. *a a a a,* furrows 5½ feet apart; *b b b,* cabbages 21 inches apart in the row; rows distant from each other 5½ feet, or 3 rows in a rod.

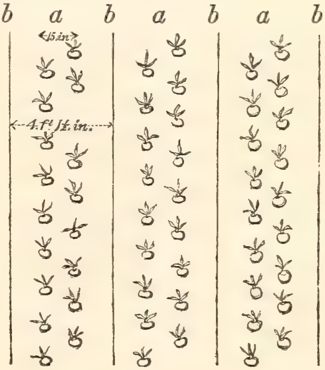
By planting at the distance of 5½ feet, the injury done by carting on the manure and carting off the cabbages is entirely prevented, as the wheels of the carts always run in the furrows. It takes 4826 cabbages to plant an acre (these, pricked out to 4 inches apart, are bought at 1*s.* 6*d.* per 1000); the planting is done from 4 in the afternoon to 7 or 8 in the evening; the plants thus have the advantage of the coolness and damp of night, and by that means gain strength to stand the heat of the following day, but during dull weather the planting may go on at any time.

The cultivation between the rows is done by the common plough; the land is first ploughed away from one side of the rows of cabbages, cutting as close to the plants as possible, the soil is then turned back, each other space is left unploughed for 4 or 5 days, for this reason, that the ploughing is done so close to the plants that it breaks off a great number of roots, and if the roots on both sides were cut by the plough on the same day the cabbages would suffer, whilst, by ploughing on the other side 4 or 5 days afterwards, the roots that have been previously cut off short have time to send out an increased number of young fibres, which support the plant while the other side is undergoing the operation of ploughing. The benefit to be derived from the cutting off the roots is, the increased number of spongioles, or young feeders sent out by the broken roots; the plants, being furnished with a greater number of mouths, must, as a matter of course, take in an increased amount of food, which acts upon the plant by producing a quicker growth. The gentleman who practises this system of cultivating cabbages was told that it would not answer during dry weather, but he asserted that if the plan suited a wet season, he was sure it would succeed in a dry one; the ploughing

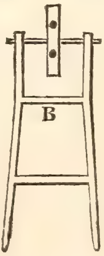
between the rows pulverizes the soil, and causes it to attract a greater quantity of moisture; the increased number of roots would, of course, extract from the soil a greater amount of water, and of those substances held in solution by the water. The fresh pulverized earth given by the plough is very acceptable to the cabbages; the land has an almost perfect fallow, and grows an excellent crop.

The carting off the cabbages is done in such a manner as to be productive of as little injury to the land as possible. This is done with a quarter-cart, as it is termed in Suffolk, having the shafts so placed that the horse walks before the right hand wheel; in other words, it "quarters." With this cart the wheels and horse are made to go in the two furrows, the body of the cart passing over a row of cabbages which are filled into the cart as it moves on.

Mr. Downing's plan of growing swedes and beet is somewhat similar to that adopted for cabbages, as it has the same end in view of making a fallow, and preventing injury to the land by carting. *a a a*, double rows of plants 15 inches apart; *b b b b*, furrows 4 feet 1½ inch apart, or 4 ridges in a rod; the plough, &c., is used repeatedly between the double rows. The manner of carting off is to have the horse walk in the furrow, *b*, and the wheels go upon the edge of the ridge at *a*, where the plants stood; but these have been pulled, topped, and tailed, and laid on one side away from where the wheels go,



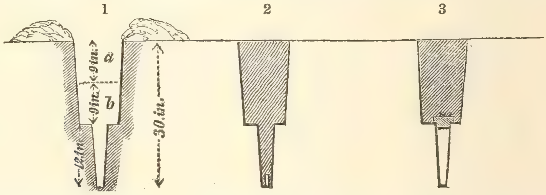
and are ready for throwing into the cart. Mr. D. uses a dibbler of the following construction for dibbling swede and beet seed: he gets a wheel from the iron foundry of about 18 inches diameter, has holes drilled in this, 7 inches apart, for 1*s*., then wooden dibs about 1½ inch,  turned, and fixed in by a nail, the other part made by the wheelwright. If too light, he has a stone weight hung on the bar, B; with this he dibbles mangel and swede seed at 7 inches apart, dropping the *turnip* seed from a bottle with a large quill stuck through the cork, the seeds are dropped with a jerk, and it does capitally. In dibbling seeds like turnips, too many would be dropped into each hole from the fingers; but by



having a bottle as here described, the seed is dropped in equal number. With the same dibble he marks the ridges for cabbages at 21 inches, passing over 2 holes, and planting the cabbage in the third; and when transplanting swedes, he leaves every other hole. To secure a plant, he dibbles beet and mangel at 7 inches, but hoes up every other knot of plants, leaving them at 14 inches. His dibbler admits of one end of the axle moving further back, so that when dibbling ridges the man does not walk on the ridge but in the furrow.

The root-crop is variously used, and it may be said with correctness to be given to cows, fat and lean cattle, sheep, and hogs. Beet affords food for fat cattle during spring and some part of summer, and is sometimes given to fat sheep, and to ewes and lambs in the spring. Turnips are stored by some for fattening purposes; some remove them daily from the field where they grow, to be thrown out on pasture land for lean cattle or sheep, while others exercise the precaution of carting early from the field, and setting them up close together in some convenient spot of ground: the objection to this is, that the tops decay and make the roots in a dirty state.

Draining on arable land is done during the fallow, and is as much

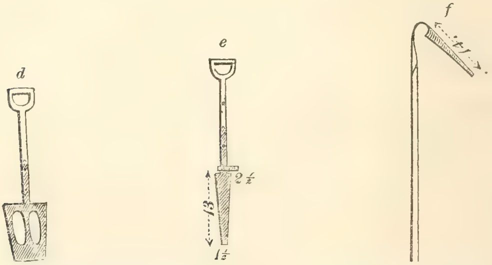


1. Drain before it is filled up. 2. Drain filled with tile. 3. Drain filled with turf.

Drain No. 1.

a 9 Inches ploughed out.
b 9 Inches dug with Broad Spade.
c 12 Inches dug with Narrow Spade.

30 total depth.



d, Broad Spade for Digging Top Spit. *e*, Narrow Spade for Bottom Spit.
f, Scoop for taking out the Crumbs after the Narrow Spade.

10 10 20 30 40 50 Inches.

practised on the heavy land of Suffolk as in any of the adjoining counties; but as the reporters of those counties have already given full details of a similar system, I beg to refer to their reports, and to the excellent article of the Rev. Copinger Hill on Suffolk Draining, in the 'Journal,' vol. iv. p. 23. It would be useless to attempt to give a better description than that gentleman has done. I shall merely give a section of the common drains, and a sketch of the narrow spade used in taking out the lower spit, as well as of a spade which is sometimes used in digging the upper spit; it is half fork half spade. In digging stiff land with this tool, the advantage is in the ease with which it enters the land, and in the soil not adhering as it does to the common spade in wet weather.

Drains are drawn across the stetches, that is, across the direction the land is ploughed, and when new drains are required (the time of renewal depending upon the nature of the soil, though usually from 10 to 20 years) they are cut across the old ones; the materials used in filling up are "haulm" (stubble), straw, "scuds" (twisted straw), ling, or bushes; these are all used on the same principle, viz., that of a temporary means of forming an arch, for these substances decaying after a time, leave a passage for the water covered by a solid arch of soil. Plug-draining and the filling with turves, brought from the fens (the latter much used, as they save straw) are means of forming that arch at once. Pipes, either circular or this shape  (the latter preferred because they fit the drain), are getting into use, particularly where supplied by the landowner; the drain is dug in the same manner as for the other filling materials. In putting in the pipes the man begins at the lowest end of the drain, and walks on them as he proceeds in his work. The cost for labour in digging out and filling in the materials, and the soil which has been thrown out, is on the average 4*s.* per score rods for 30-inch drains; when pipes are used the cost is rather more. Drains for pipes are sometimes dug 3 feet deep by digging two spits with the broad spade; this does not much increase the cost for labour, and may be of advantage, as it removes the drain further from the plough; it also admits of subsoiling, which is out of the question in the common method of filling in, as that operation would destroy the arch that had been formed. However, many of the heavy land fields of Suffolk are nearly at a dead level: hence it would be impossible to adopt a very deep system of draining, as a fall of water could not be obtained; even at the present depth difficulty is sometimes experienced in getting a fall, when the openings of the drains are only just above the level of the water in the ditch into which the drains run.

2nd Year, Barley.—On a long fallow the seed-earth is given

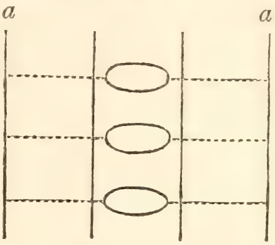
before Christmas; the land then lies till February or March, when it is scarified or well harrowed and the seed drilled at about 6 inches, with from 10 to 12 pecks per acre: a set of light harrows follow to cover the seed. The varieties usually grown are the long-ear Nottingham, and the Chevalier. This last was introduced by the late Dr. Chevalier, of Aspall, in this county; it is the finest, though not the hardiest or most productive kind of barley grown. A full account of the origin of this variety is given by Dr. Chevalier, in the Journal, vol. i. p. 11.

Land, for barley after roots, is ploughed as soon as the roots are off; across the ridges if ridged, some plough twice, giving a shallow ploughing first, and then a deep one; this is of advantage, as it brings the land level, and mixes the manure that had been applied to the root crop. The leaves of beet are ploughed in, and found to be productive of much benefit.

An improvement has of late years been brought into practice in some parts of the county, that of sowing about a peck of white mustard per acre on the long fallows in August or early in September, and ploughing in the herbage about 6 or 8 weeks from the time of sowing. To assist in covering it in, several methods are employed: the roller is used before ploughing, a chain is fixed to the plough, or, what is perhaps the most effectual plan, having boys to put it in the furrows after the plough; the effect on the barley crop is considered by practical farmers to equal half a coat of muck, obtained at a cost of 2*s.* 6*d.* for seed, and the additional trouble of sowing and harrowing in the seed. White mustard is sometimes sown for feeding, and it has also been sown after peas for ploughing in as a manure for wheat. Mr. Kemball, junior, of Buxhall, tested this practice by leaving a portion of land unsown: he states that the difference of the crop was visible to the eye at a considerable distance from the field; at harvest, the wheat where the mustard had been ploughed in was 6 inches the highest, and ripened 10 days sooner than the wheat on adjoining stetches where no mustard had been sown; this was on a clayey loam. Barley is horse-hoed by some farmers; this is of advantage, particularly where the system of late sowing clover seed is adopted; some consider that the land must be in a bad state if barley requires horse-hoeing, and are therefore content with hand-weeding.

On an average, 1 peck of clover-seed is sown broadcast by hand, or with the machine directly after the harrows which follow the barley drill: the land then receives another light harrowing. Another manner of sowing seeds, which is useful when the barley crop is sown so early that it is likely to be injured by the clover, is that of horse or hand hoeing the barley, and then sowing the seeds broadcast and harrowing in.

The manner of gathering barley at harvest is different from that practised on the light lands; here the barley is mown across the stetches or beds, and when fit to cart, is gathered by the wives of the harvestmen, who use hand-rakes for the purpose of rolling the barley into rows; they rake the swaths off three stetches into a shock, leaving a passage for the waggons in the furrows, *a a*.

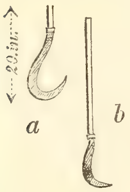


Barley is harvested either in the stack or barn, though more frequently in the latter; a greater quantity is got into the barns by trampling with horses, though this practice is occasionally injurious, from the barley becoming mow-burnt when badly harvested.

By far the greater part of the barley is threshed by the flail, at a cost of from 10*d.* to 1*s.* per coomb. Machines for havelling barley, in lieu of the old-fashioned barley-choppers, have lately been introduced: these perform the operation perfectly, though many farmers complain that from the machines cutting the awns off so short, the barley does not fill the bushel so quickly as before the machines were introduced; however, as maltsters will pay for even samples, there does not appear any likelihood of havelling machines being laid aside.

3rd Year, Clover, Beans, and Peas.—That portion of the barley-stubble intended for beans and peas is manured with farm-yard dung, usually from 14 to 20 loads per acre, and then ploughed up; this is generally completed before the frosts of winter set in, by that means exposing the land to the ameliorating effects of the weather during winter, and this adds another link to the system of avoiding spring-ploughing, and sowing on a stale furrow, which are, I believe, the strong points in the husbandry of the heavy-land farmers of Suffolk. Some farmers give a half coat of dung for beans, and the other half for wheat; the dung for beans is not ploughed in very deep, as it is considered that beans require a firm bottom, and that by ploughing deep for wheat the manure applied for beans will be brought nearer the surface. When drilling beans and peas is practised, the land is scarified before sowing to let in the drill, but for dibbling this is not required. Beans are planted from 6 to 8 rows on a 12 furrow stetch (peas rather closer), the time of planting February and March, but this depends on the weather. About 2 bushels of common small beans are planted to the acre, about 4 of Windsors and Mazagans, and from 3 to 4 bushels of peas. Beans are hoed twice, and sometimes three times, with a heavy hoe (by

some farmers the horse-hoe is used, and with much advantage), at a cost of 4*s*. for the first hoeing, and of 2*s*. 6*d*. or 3*s*. for the second. Some plant their beans on ridges, either one or two rows; if two, 8 or 9 inches apart, the ridges from 27 for one row, to 42 inches wide for two rows, and then plough and horse-hoe between the intervals. Beans are either pulled by women and children or cut with a hook, (*a*) "scrogged." Peas are either mown, or the pea-make (*b*) is used for the purpose.



Peas with barley are used to some extent for fattening pigs; beans for horses and bullocks. Bean-meal with oil-cake is frequently used, and is reckoned better than if they were given separately.

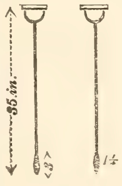
Manure is frequently carted on the clover in the winter during frosty weather; when this is done the land is not dunged for wheat; this is preferred by many, as the clover gets the benefit, and the wheat-plant comes better than when the manure is laid on a short time before ploughing for wheat.

Italian rye-grass is grown in some places in lieu of clover; it must be useful on land that is clover-sick, as allowing a longer interval to elapse before it is again sown on the land. Clover is sometimes mown for "stover," (that is, hay) the second crop being either fed or mown for hay or for seed, though some cart into the yards for horses. The manner of making hay has nothing remarkable in it to deserve a description.

Seed-clover is grown to a considerable extent; the practice is to feed red clover till June, and white till May (not folded), and then shut up for seed; the feeding with sheep makes the clover blossom more at once. Red clover is sometimes mown for hay, and then seeded; but the lateness at which the seed is harvested renders this an uncertain practice. Stones are picked off the layer during winter, and the thistles and other weeds chopped up a short time after the crop is shut up for seed. White clover is mown early in the morning and late at night in dry weather, for when damp the seeds do not brush off: this is not required for red clover; men or women follow the mowers with close-toothed iron rakes, for the purpose of collecting the heads of clover that fall between the swaths. The cost of mowing is from 2*s*. to 2*s*. 6*d*. per acre, that of raking about 1*s*. per acre. The clover is turned and lifted as occasion may require, a rake following each man that turns. When fit to cart, the seed is gathered in rows with hand-rakes in the morning, while the dew is on the ground, in a similar manner to barley, the intervals between the rows being sufficiently wide for the passage of the waggons; in pitching, the seed is handled as carefully as possible. When carting white

clover, women and children follow the waggons to pick the locks of clover left by the pitchers. After carting, the field is raked while the dew is on the ground. The seed is either threshed by hand or by the machine; the cost of "cobbing," separating the seed from the stalks, and "drawing," separating the seed from the husk by hand, is from 4*s*. to 5*s*. per bushel of 5 stone; seed is drawn on a wooden frame on which the cob is laid, while 5 or 6 men hammer away with flails; however, this is much better done by machinery. A crop of red clover-seed is 2 to 8 bushels, of white 3 to 9 bushels (of 5 stone) per acre.

4*th year, Wheat.*—Wheat follows in the last year of the course after beans, peas, and clover. From 14 to 20 loads per acre of farm-yard manure, generally compost, are applied on clover-lands for the wheat crop, either on the seeds during the previous winter, or shortly before ploughing up the land for wheat; the clover-land is ploughed up (not very deep) in September, allowing a short time to elapse before planting. When the layers have been fed, it is considered advisable, from the greater part of the manure from the sheep washing into the furrows, to spread the first furrow ploughed up; by this means the manure is distributed over the surface; if this is not done, the corn that grows on the ridge or top of the stetch is lodged. When manure is spread, it is never thrown in the furrows, for these become by ploughing the top of the stetch, on which the succeeding crop is grown; and it is found that that is the part where the crop grows with the greatest luxuriance. Wheat is generally planted in October or November, either with the drill or by hand-dibbling; the latter is preferred for clover-lands. The dressing to prevent smut was chiefly chamber-lye and lime; this has been superseded in many places by a solution of blue vitriol (sulphate of copper). Arsenic is also used; this is done by wetting the wheat, and then sifting arsenic over it from a dredging-box. Before dibbling the land is rolled. Dibbling is done by men who use two iron dibblers, one in each hand, walking backwards; one man finds employment for three children dropping the seed; the cost from 5*s*. to 8*s*. per acre; the distance between the holes varies from 3 to 5 inches, that between the rows from 4½ to 9; thus one row of holes is put in the centre of each furrow, or two rows on a furrow; and some put 16 rows on a 12-furrow stetch, putting two rows on the wide furrows, and only one on the narrow ones at the ridge and furrow. After the seed is deposited, the land is harrowed. Among the advantages of dibbling are—



1st. The employment of the labourer and his family.
2nd. The saving of seed (from 6 to 7 pecks usually dibbled).
3rd. That the straw grows stiffer, and is not so liable to be lodged.

Bean and pea land, that has been dunged for those crops, is not dunged for wheat, though some farmers give half a coat for beans, and the other half before ploughing the land for wheat. Clover is considered the best preparation for wheat. The bean and pea land is cleaned after harvest by scarifying and harrowing, and then ploughed. Drilling is generally practised on bean and pea land, and by some farmers after clover; the distance between the drills varies from 5 to 9 inches, with spaces of about 1 foot in width for striking out the furrows. The wide drilling, which Arthur Young speaks so highly of, has been laid aside, as it has been found, after an experience of many years, that it does not equal that drilled at narrower intervals. The land is harrowed both before and after the drill, a light gang of harrows being used last for covering the seed. The furrows are now struck out with a double-breasted plough, drawn by one horse, which leaves the wheat well laid up for the winter. The quantity drilled is from 8 to 10 pecks. The red varieties chiefly grown are, the Spalding, the Copdock or marygold, and the old Kent red. The Tunstall white, grown from a single plant at Tunstall, Suffolk; the Hardcastle, a white wheat, brought into notice by a farmer of that name living near Ipswich, and a great favourite with the Suffolk farmer; some grow red and white wheat mixed, a sample which commands a higher price in the market than red only.

Horse-hoeing wheat is only partially practised, though hand-hoeing and weeding are very general, but perhaps are productive of some injury when done too late in the season.

By far the greater portion of the wheat is reaped, and for such abundant crops as are generally grown this is preferable to mowing; however, mowing or bagging is to be recommended on land intended for beet or tares, requiring to be ploughed up immediately after harvest.

Harvestmen are either paid a certain sum per month, or receive about 10*s.* per acre for cutting, carrying, and stacking the grain, from 10 to 12 acres being allotted to each man, the wives and children assisting in the harvest when required by the men.

A great quantity of wheat is still threshed by the flail, at a cost of from 1*s.* 2*d.* to 1*s.* 6*d.* per coomb; and I believe that there are covenants in some leases binding the farmer to thresh by flail, and that some farmers prefer it, because they are able to employ more labourers, who otherwise would be obliged to fall on the parish. I think that landowners and farmers of this opinion require a little more schooling to convince them that money saved by machinery can be employed in improved cultivation.

Management of Light Land.

I have included the eastern and western light-land districts

under one head: this may be objected to, but the prescribed limits of this report will not allow of any other arrangement. The management, in some respects, may be different, but, where any difference occurs, it will be mentioned. Many of the light-land farms on the eastern side of the county are of so varied a character of soil as to require distinct systems of management, and may be said to partake both of light and heavy land farming. It would, therefore, require a considerable space to give all the details, and this must be my apology if I have omitted any important features. Beet-root is grown largely on the eastern side of the county on good soils, and has perhaps in some measure superseded the cultivation of carrots, for which the light land was celebrated in the time of A. Young. The proximity of the sea, combined with dry and warm summers, no doubt render this district favourable to the growth of that root.

The whole of this district is (with very little variation) farmed on the four-course system:—

1st year—Fallow, swedes, white turnips, carrots, or mangold-wurzel.

2nd year—Barley.

3rd year—Seeds.

4th year—Wheat.

On the very light sands swedes and mangold are not grown, and rye is grown as a corn-crop; but the latter is not so much cultivated as it used to be. Oats are occasionally grown instead of barley and wheat.

1*st year, Fallow.*—On most of the farms in this district a breeding-flock is kept, and in order to supply food for the ewes and lambs in the spring, in the interval that elapses after the turnips are consumed, and before the layers are sufficiently advanced for feeding, a portion of the fallow is set apart for the growth of rye for feeding off, to be followed by white turnips. As soon as possible after harvest, a portion of the wheat-stubble is ploughed up. The cleanest stubble is generally selected for this crop, though on some farms the practice is to take rye for feeding alternately on the several fields of the shift; one ploughing is given, and the seed drilled or sown broadcast (if drilled, the coulters of the drill are as close as possible), at the rate of from 3 to 3½ bushels per acre; the quantity of seed may appear great, but it is generally considered that rye for feeding cannot be sown too thickly. A few tares or rape-seed are sometimes sown with the rye; this thickens the bottom of the feed. Within the last few years an early variety has been introduced, for the purpose of feeding off in the spring; it is called the giant or Tyrolese rye, and it has the great advantage of coming a week or ten days earlier than the common rye, though some farmers do not consider the

produce equal to, or the feed to continue so long as that produced by the common variety, but this deficiency, if it exists, is more than compensated by the advantage of having feed 10 days earlier; this is of great importance to the flockmaster when the spring is severe, or when there is a short supply of turnips. The time of feeding off the rye is of course determined by the severity of the winter, and by the time at which the turnip-crop is consumed. The usual period being from the middle to the latter end of April, if allowed to get too forward the sheep do not eat it readily. The sheep are usually folded in hurdles on the rye, a fresh piece being allowed them every day. Some of the hurdles are set so that the lambs can get through and feed on the fresh rye at the head of the fold, whenever they feel inclined. It is the practice of some farmers (and one which is much to be recommended when the turnip-crop is abundant) to cart the last of the turnips into the rye-field, and give them to the sheep while feeding the rye. The cost of carting the roots will be amply repaid by the convenience of being able to proceed in the sowing of the barley-crop at a seasonable time; the loss to the land by not being folded can readily be supplied by some artificial manure. Green rye, in a forward state, is often mown for horses, and cut into chaff with a mixture of straw; it is useful as affording the first gradual change from the dry food of winter to the green food of summer.

The cost per acre of rye for feeding is rather heavy; but, at present, the Suffolk farmers have not discovered any crop that so well fills up the blank between the consumption of the turnip-crop and the time at which the grass and clover are ready for the sheep.

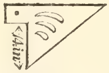
As soon as the rye is fed off, the land is ploughed up and prepared for turnips, which are drilled about the latter end of June or beginning of July. The number of ploughings, scarifyings, &c., which the land receives depends upon its cleanness, and also on the difficulty that exists in bringing the rye-land into a sufficiently pulverized state. Farm-yard manure is seldom used for turnips after rye, but artificial manures, such as rapecake, bones, and latterly guano and superphosphate of lime, are frequently drilled in with the turnip-seed.

A farmer in the neighbourhood of Wickham Market grows swedes and white turnips after rye with only one ploughing, and never fails of securing a good crop.

On most farms a few acres of tares are sown for the purpose of soiling horses, or occasionally for feeding sheep. The management does not materially differ from the cultivation of the land for green rye.

Having thus disposed of a portion of the fallow (on some farms about one-fourth of the entire shift), I shall proceed to consider

the plan of working the remainder. The manner of preparing the land for turnips is not uniform in this district, and the practice frequently varies on the same farm, one system being adopted one year, and another the next. If a dry autumn succeeds an early harvest, we shall in all probability see the *whole* of the fallows cleaned of couch and other rubbish *before* the clover layers are ploughed for wheat; but if it happens to be a wet autumn, or a late harvest, the cleaning is of necessity deferred till the spring. The practice of some farmers is to skim-plough as soon after harvest as possible, the skim being either a skeleton-plough fitted with a share of from 14 to 16 inches in width, with three short prongs of iron rising from the share in the annexed form, for the purpose of breaking the land; or it is a common plough divested of its mould-board, and fitted with one of these broad shares.



Upwards of $1\frac{1}{2}$ acre of hard land may be thus ploughed with a pair of horses in a day.

The advantage of the skim-plough over the scarifier in breaking up stubbles is that it will enter harder land, and it does not choke as scarifiers and cultivators do in these soils, from the quantity of hog-grass or wireweed with which the stubbles are sometimes covered after harvest; besides, the sandy and gravelly soils are more subject to couch than perhaps any other description of land. After the land is broken up with the skim-plough heavy harrows are used to pull the land a little to pieces, and to bring the clods to the surface; the roller is then employed to break the clods, which generally leaves the land in a sufficiently pulverized state for the lighter harrows that are now used for collecting the rubbish into rows in regular lines across the field and on the headlands. The man who drives the harrows is accompanied by a strong lad, who assists in unloading them. The rubbish collected in this manner is either burned or carted off. The scarifier is now used across the ploughing, and the harrowing repeated, when the chief portion of the rubbish is thus pulled out of the land by the scarifier and collected by the harrows; any straggling pieces of couch-grass are picked up by women and children. The plan of raking the couch-grass and other weeds from the land, after they have been pulled to the surface by harrows, is sometimes adopted; and, when the land has been finely pulverized, it is a very effective way of collecting the rubbish. Large companies of women and children, accompanied by an overlooker, are often employed either in picking or raking; and when the couch, or spear grass, as it is here termed, only occurs in small patches, it is very common to have these forked out piece by piece previously to the stubble being broken up. After the land has been cleaned in this manner, it is ploughed in wide stetches (usually 3 rods).

Another system of fallowing is adopted by many, namely, that of "ribbling;" this is done by turning a furrow to the unploughed land, and, in returning, to turn over this furrow and the earth upon which the first furrow was laid, so that the land lies in ridges during the winter months, and is thus exposed to the full action of the weather. In the spring these are harrowed and scarified across, and then ploughed.

Others merely plough the stubble in, and then let the land lie through the winter, when the furrows are turned back, bringing the couch grass, if any, to the surface; instead of turning back the furrows, some adopt the plan of "ribbling," in the spring, across the first ploughing, and by this means bring the couch to the surface; the land is then cleaned with the harrows and scarifier in the usual manner.

The custom of ploughing in the stubble is the old-fashioned method, which many still consider the best, and give the following reasons for their opinion: the stubble, and all rubbish in the shape of weeds except couch, will rot during the winter; and not only spare the trouble of getting together and carting them off the land, but will tend to increase the fertility of the soil. This is the opinion of some: and undoubtedly it is good management when the land is perfectly free from couch, and other creeping-rooted weeds: but where an opportunity occurs of cleaning foul land in autumn, it must be wrong to defer doing so till the busy time of spring. How often it happens that the soil during the months of September and October is in a better state for cleaning operations than at any other period between that time and turnip-sowing.

The following description of the preparation of the land for roots applies to a particular farm, though the system in some degree resembles that practised by the neighbouring farmers. The land on this farm is a sandy loam, in some parts inclining to brick earth. The practice of ridging is adopted on the stiffest land, and also that of subsoiling. In these respects the management differs from that practised on the very light sands, where the turnips are drilled on the flat; though where the land partakes at all of a clayey or loamy nature, the ridge system is generally adopted for swedes and mangel.

"Preparatory to ridging or ploughing in the manure, the land is brought into as pulverized a state as possible; this being considered indispensably necessary for the success both of ridge and flat cultivation. No regular system of preparation is adopted; as this, of course, depends upon the weather, and on other circumstances requiring the exercise of proper judgment as to the course to be pursued. But one maxim is adopted: that of cleaning the land from couch and other weeds *in the autumn,* when possible; and to aid in accomplishing this end the practice of mowing wheat

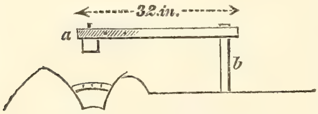
lends a helping hand. This cleaning is performed by the due application of the skim-plough and scarifier, with harrowings and rollings as occasion may seem to require. In addition to what has already been stated, the spear-grass and other weeds torn out by the scarifier are collected by repeated harrowings, rakings, and hand-pickings, and are then carted off the land. When the land is brought into a perfectly clean state—and when the weather and the other more pressing operations of the season, such as wheat-sowing, carting-off, and storing away roots, will allow—the plough followed by a subsoil plough (the Rackheath or Reid's sub-pulverizer), the latter drawn by three horses, is set to work. The land is thus stirred to the depth of 14 or 15 inches, and lies exposed to the full action of the frost during winter. This will in all likelihood complete the preparation till the ploughing-in the manure and drilling the seed. In order to prevent the trampling of the horses on the subsoiled land, the horses in the common plough walk on the unploughed land, instead of one walking in the furrow where the subsoil plough has just been. The line of draught is adjusted by altering the head or bridle of the plough. In shutting up the furrows the horses are made to go at length instead of abreast. By adopting this plan the poaching the land is prevented. This may not appear to be very injurious at the time; but the parts compressed by the horses' feet will in wet weather be found to hold water.

A wet autumn and winter will not allow these operations to go on so smoothly. We must then be content with simply ploughing the cleanest fallows, and with using the skim-plough or scarifier across those that are foul. Any further attempt at cleaning is left till the dry weather of spring commences; and having got rid of the couch and rubbish by the same system of operations as before described, ploughing is resorted to in order to bring a sufficient depth of mould. But by ploughing at this season of the year, clods are very likely to be produced. To pulverize these the land is always kept harrowed and rolled *immediately* after the plough. If these do not bring the soil into a fine surface, recourse is had to that very effective implement, Crosskill's clod-crusher. Another ploughing may succeed with the same accompaniment of harrowing and rolling. And taking it for granted that these operations have been done at proper seasons—viz. when the land is neither saturated by recent rains nor hardened by long-continued drought—the field ought by this time to have a sufficient quantity of fine moulds for ploughing in the manure, and drilling the seed to the best advantage, and in a workmanlike manner. During the winter the farmyard manure intended for the root-crop is carted to the field, and laid in the most convenient places for its future application on the land at the time of turnip-sowing. Wet weather is

generally taken for carting from the yards: no particular season is chosen. The muck is either laid on a bottom formed of clay, mould, peat, or ditch stuff; or sometimes it is laid in a heap without any heavy material. In unloading, the carts are drawn on the manure heap, and kicked up; a man being employed spreading the manure as it arrives. The pressure given to the dung by the loaded carts of course prevents loss by decomposition. The manure is taken from different yards, so that the dung may be mixed in the heap. A few weeks before carting on the land the dung-heap is turned over; should it consist of dung and earth, care is taken to mix these well together. Fermentation now commences; and the manure requires to be applied to the soil before this advances too far, or a great loss will be sustained in the bulk of the heap.

The land and manure being thus prepared at due time, the process of covering in the manure commences. It is first to be considered which practice is to be adopted, ridging or flat-work. On very dry land the latter has the preference: but on good land ridging may be adopted with a certainty of getting a good crop. On heavy clays, where there is no possibility of reducing the clods to a fine state, no advantage will attend ridging, except that some facility is obtained for carting off the roots. However, ridging may be adopted on heavy soils if the land is prepared in the autumn.

When the ridge-system is adopted, the ploughman begins by drawing out a few ridges preparatory to the general beginning. By giving him a slight start stoppage is prevented. The ridges are made 27 inches apart, and to keep these of the exact width a marker is attached to the plough of the annexed form; this is placed upon an iron pin *a* at one end of the beam, the other end being secured by a line from the head of the plough. The part *b* of the marker draws a slight furrow, in which the ploughman can go with unerring correctness; at the end of each furrow the ploughman changes the marker to the other side of the plough.



When a few ridges have been ploughed in advance, the other operations follow. The manure is carted, spread, and covered in; the ridges rolled, and the seed drilled, in rapid succession. About 3 acres are completed with two ploughs in a day of eight hours. The workmanlike style in which the ridge-system is carried out by some of the Suffolk farmers will, I have no doubt, bear comparison with the best cultivated farms of the north of England.

In addition to the farm-yard manure, some artificial manure

is sometimes drilled on the ridge; this is done with a manure drill, the coulters of which are guided by rollers which at the same time roll the ridges. The seed is not sown by this drill, for as the manure coulters make a very deep furrow it would be unwise to deposit the seed immediately. But by using a light roll, this furrow is filled up, and the ridge levelled for the seed-drill to deposit the seed at a regular depth. Guano is sometimes sown by hand, in immediate contact with the manure; this is of course done before the ridges are split.

Before hand-hoeing the turnips or beet, they are horse-hoed, a man and horse getting over about 3 acres in a day; between the first and second hand-hoeing the horse-hoeing is repeated, and after this as often as may be required.

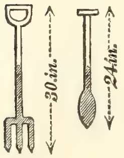
The spaces in the mangel or turnips, which have missed plant, are filled up with transplanted swedes. Swedes are also transplanted after tares that have been mown for horses, and are found to produce good crops.

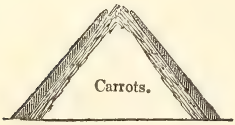
The system of drilling on the flat is generally adopted on nearly all the lightest land of this district, both for swedes and common turnips: when farm-yard manure is applied, it is carted on and spread just before the ploughs, so that as short a time as possible elapses between the spreading of the manure and the covering of it in by the plough—it being so arranged that the men spreading, followed by women and boys to divide the dung, are just able to keep the ploughs in work. Some plough the manure in fleet, and then plough deep before sowing. Most farmers drill directly after the plough, and some, in order to ensure a good crop, drill artificial manure with the seed, such as rape-cake, greaves, bones, superphosphate of lime, &c.

On a few farms peat-ashes are used. I have before said that there is a narrow tract of peat soil on the banks of the river Lark, and this is prepared by being burnt in large heaps, at a cost of about 5*l.* per thousand bushels for digging and burning; these ashes have been used rather extensively on a few light-land farms for turnips; they have likewise been found to be productive of much benefit when applied as top-dressing on sainfoin and clover layers. The gentleman who first introduced the use of peat-ashes has also another practice worthy of mention, which is, the using two drills, one to sow the artificial manure, and the other to drill the seed; this is preferred, the seed being deposited regularly, and at a uniform depth, which is seldom the case when the seed follows immediately after the large manure coulter. This is a desideratum which is still wanting in drills made for the purpose of drilling manure with the seed. The time for drilling swedes is May and June; white turnips, June: the average distance between the drills 18 inches. Some farmers have adopted the practice of horse-

hoeing their flat drilled turnips, and it is a practice very likely to increase; as, in addition to the advantages derived from the pulverization of the soil and the destruction of weeds, the process of hand-hoeing is rendered easier and more effective. Garrett's lever-hoe is used by many farmers on the light land of East Suffolk. One gentleman, who farms 2200 acres, hoes turnips both between and across the drills, cutting out the plants at regular intervals; these are singled by hand and then hand-hoed. In the first hand-hoeing, or singling of the turnips, the hoer is often followed by a girl or boy to single the turnips left by the hoe. In about a fortnight the turnips are hoed a second time, the cost of both operations being about 6*s.* an acre.

Carrots are either sown broadcast or drilled. The land being ploughed deep or subsoiled, farm-yard manure is seldom used, as it makes the roots fangy. The management of the carrot-crop is frequently by contract labour; the contractor finding seed, sowing, hoeing, taking up and storing the crop: for this he takes half the crop, or is paid 2*d.* per bushel. About 5 lbs. of seed is sown to the acre in April, the seeds being first mixed with dry sand to ensure its delivery. As soon as the young plants can be distinguished, the weeds are hoed with a small hoe about 3 inches wide, having a handle little more than a foot in length; this is a very slow and tedious operation. In a short time the carrots are set out at about 6 or 7 inches apart with a wider tool, and again hoed about the latter end of July. The cost of hoeing varies from 20*s.* to 30*s.* per acre. The carrots are taken up in October or November; men and women take them up with forks, or with a spoon-shaped tool; children cut the tops off as they are taken up. They are then laid in long heaps, either in the field, or carted to some convenient spot; these heaps are about 3 feet wide at bottom, and 2½ feet high. They are first covered with straw, and then with earth, except the ridge, which is covered with straw only. In the spring the stored carrots require looking over. The tops are folded with sheep.





Section of Heap.

Drilling carrots is practised by some, and has several advantages over broadcast, as, first, it lessens the cost of hoeing; secondly, the carrots are singled at wider intervals, consequently they produce a heavier crop, as the roots are larger and the carrots being at greater distances apart the taking up is not so expensive. Before drilling the seed is mixed with sand, bran, or other substances to divide the seed. One farmer uses powdered wood-charcoal; the latter produces a quick vegetation of the seed, and also prevents it from

adhering in the drill; it is thus drilled as regularly as the nature of the seed will allow: the drillman will, however, most likely object to this admixture, as the charcoal-dust gives him much the appearance of a chimney-sweep. The land harrowed before, and rolled before and after drilling with a very light roller; the distance between the drills on light land is about 1 foot. The carrots are up in about three weeks, and in about a fortnight more the rows will be sufficiently visible for a 6 or 8-inch Dutch hoe to be used between them; in about a week or ten days after the Dutch hoeing the carrots are singled out with the common hoe, selecting all the strongest plants at about 8 inches apart; this costs from 5*s.* to 6*s.* per acre, and in three weeks or a month they require another hoeing.

The crops of carrots vary from 400 to 1400 bushels, or from 10 to 30 tons per acre. The purposes to which they are applied are feeding horses, cows, and fattening bullocks, for all of which they have been proved excellent.

This is the system practised on the western light lands. I am indebted to J. Rodwell, Esq., for a description of that of the eastern district:—

" *The Cultivation of White Carrots.*

" Choose a clean piece of wheat or barley stubble, supposing it to be free from grass: in November or December give it a dressing of from 12 to 15 loads per acre of farm-yard manure, then plough it in with a flat ploughing of about 4 or 5 inches deep: in about February or March give it a ploughing of about 9 inches deep, followed by a subsoil ploughing of about 5 or 6 inches additional depth, making the soil all broken at least 14 inches deep: it then lies till about the middle of April, when give it two or three heavy harrowings to destroy the surface weeds, then follow this with a 2-horse roll to keep in the moisture and again to encourage vegetation; it then lies in this manner till the time is come for putting in the seed, which will be about the last week in April or the first week in May; then give it two or more harrowings as may be required, followed again by a 2-horse roll if the land is dry or cloddy, if it is not, a light barley roll is preferable; it will then be prepared for the seed, which should be put on with the drill as follows:—

" The seed is laid in water in a bag for 48 hours about 8 or 9 days before drilling; it is then taken out and spread on a floor about 9 or 10 inches thick, according to the temperature of the weather, so as not to let it get too warm; in about 6 or 7 days' time it will be nearly sprouted, when it will be quite time to put it in the ground, at 4 lbs. or 5 lbs. of dry seed to the acre, which deposit by mixing dry sand with it, making up altogether sand and seed mixed 4 pecks or thereabouts, according to the dryness and fitness of the seed for working through the drill; then follow the 1 or 2-horse roll with the drill as above mentioned, the rows at about 9 or 10 inches apart, the land after the drill being left with the drill marks quite open; the land is then left till fit for hoeing, which

comes on between the rows in about 20 or 25 days; the expenses of hoeing will vary according to season, but average from 15*s*. to 25*s*. per acre, when the land is to be left quite clean, and the plants all singled, so as to be about 8 inches apart in the rows. The time for taking them up will be about October or November; the expense of taking up will be from 8*d*. to 10*d*. per load of 40 bushels, according to the crop, which, upon a good sandy soil, will produce from 20 to 25 tons per acre of this invaluable root.

"The method of preserving the crop is to pack them in heaps of 20 bushels each in the field, covering them with a little *dry* straw, and over that about 3 to 4 inches of earth; they are then quite safe for the winter; but if the land is intended for an early crop, and it is necessary to remove them from the field, then lay them in rows about 3 feet wide at bottom, and throwing them up loosely in a conical form, and covering them with dry straw and earth in the above method. They will be found very nutritious food for every kind of cattle, and especially for the cart-stable, where we substitute 1 load or ton of white carrots as an equivalent to a coomb of beans when ground, or 2 coombs of oats, beginning to feed with them in October, and continuing till May. Allowing 1 load of 40 bushels of carrots and 3 bushels of ground beans, or 6 bushels of oats, to a stable of 6 horses, per week, giving them chaff with their corn and carrots, this, with straw (having neither hay nor stover), constitutes their food during the winter, maintaining them in good working condition. After the crop is taken off the land, spread the tops of the carrots as carefully as a dressing of farm-yard manure, then give it a good sound ploughing, making an excellent preparation for a crop.

"*Note.*—A proof, if proof were necessary, of the great utility of this root, is at this moment fully experienced on this farm, having horses, colts, oxen, cows, and swine feeding upon a crop of upwards of 20 tons to the acre, and this in a season when the white turnips are almost a failure in quality, the swedes are deficient in quantity and quality, and the beet-roots are entirely a failure; and when beans are 56*s*., and oats 32*s*. to 36*s*. per quarter.

"THOS. SCOTCHMER,
"Bailiff to Joshua Rodwell, Esq.
"*Alderton Hall, Suffolk, Jan.* 11, 1847."

On those farms where only a breeding-flock is kept, the whole of the turnips are consumed on the land, and this is perhaps necessary on the very light blowing sands; but another system is practised by some, that of carting off a part of the turnips for feeding cattle, in the proportion of one-third or upwards, when the land has been manured, and the system of grazing sheep on the turnips: and wherever these two systems are adopted in preference to the practice of consuming the turnip-crop entirely by breeding ewes, the benefit may easily be seen. A great objection to keeping only a breeding flock is the difficulty of providing spring food for so great a number of sheep and lambs, while grazing sheep can be sold at any time. It is generally considered

by the best cultivators that a flock part grazing and part breeding is the most profitable to keep. It is a practice of some farmers (though not much to be recommended) to have their turnip-crop fed off by other persons' sheep at a certain rate per score. They certainly run no risk by investing their capital in sheep, but they are very liable to have their turnips fed off at an unseasonable time. And I have known when turnips have been very abundant, that those gentlemen who farm without any stock are glad to have their neighbours' sheep and feed them gratis, and sometimes give money in addition; and even occasionally dispose of part of their root-crop by ploughing them in.

Notwithstanding the prescribed limits of this report, it may not perhaps be out of place to give the details of the practice of grazing sheep on turnips. The farmers who practise this system either buy in lambs or shearlings, or fatten those they have reared. These are hurdled first on white turnips and then on swedes; the practice of cutting is on the increase, the turnips having of late years been cut with a machine and then given in troughs. This makes a slight increase of labour, but it effects a great saving in the food: the cost of tending amounts to about 1*s.* a score per week. Chaff (cut hay, the straw of oats, wheat, or peas, or the stalks of seed-clover) is given night and morning both to ewes and fatting sheep, the latter having generally hay-chaff, with the addition of linseed-cake or corn. As the fold is frequently at a considerable distance from the homestead, a supply of chaff and cake is kept in a small wooden house on wheels, which not only serves to keep the provender dry, but is also a comfortable shelter for the shepherd and his assistants while getting their meals. The troughs in which the dry food is given are usually covered, to prevent loss from the sheep refusing to eat the chaff and cake after they have been wetted. In very wet weather and on a loamy soil the sheep are removed to some dry pasture for a short time, as the trampling in very heavy rains is considered injurious both to the land and to the sheep. Swedes for fat sheep are stored in different ways: the usual one is in small heaps of about 40 bushels each. The turnips are either topped and tailed, or the tops only removed; the heaps are covered with straw and haulm, and then a thin layer of mould, leaving the straw exposed on the ridge to admit the air. The price for this varies from 7*s.* to 10*s.* per acre, according as the turnips are cleaned or not. Another plan is by laying three drills in a furrow; two rows of turnips are first pulled and laid on one side to give passage for the plough, a furrow is drawn, and three drills of turnips laid with their tops to the land-side; they are now covered by the first-ploughed furrow being turned back. When wanted for use the turnips are thrown out by running a plough along the furrow.

This practice, or modifications of it, is adopted for white turnips as well as swedes, and is well suited for turnips that are left late in the season, as the former is for feeding during the severity of winter. The salutary check which the turnips receive by being pulled prevents their drawing the land by sending up seed-stalks, and, being in a more natural position than when stored in heaps, they keep sound and in good condition. Beet and swedes for feeding on the land with sheep are sometimes stored in the following manner on the eastern side of the county:—The roots are pulled from a piece of land 6 yards square, and laid in the centre of this piece in a conical heap; a few roots in the centre of the heap are topped and tailed, the remainder are laid with the tops to the outside and covered with earth 6 or 8 inches in thickness. Roots stored thus are said to keep well. The employment of the labourer and his children is not the least of the many advantages which the harvesting or storing of roots affords.

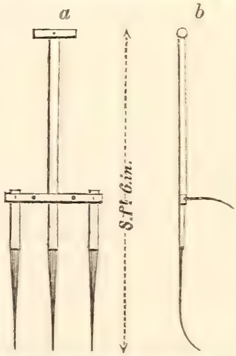
Sheep grazed on turnips are sold fat from March to June; the kind of sheep preferred for grazing is the first cross between the Down and Leicester. The breeding of this kind of sheep is much on the increase, as it unites the quickness of fattening of the Leicester with the hardiness and quality of the Southdown. This description of sheep is supplied by flock-masters who keep a Southdown flock (buying in ewes of that kind as the crones are drafted out), and hiring or purchasing Leicester rams of farmers who keep a Leicester flock for the purpose of ram-breeding. For breeding-ewes the turnips are never cut with a machine, and but very seldom stored, white turnips being generally given. Mr. Freeman, of Henham, steward to Lord Stradbroke, feeds his ewes on swedes, and I believe finds that they do better than on common turnips.

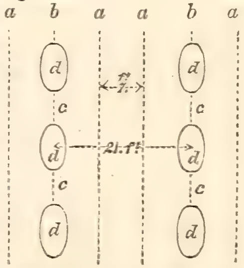
The sheep are folded on the turnips at night, and in the morning are driven out on the heaths (on the very inferior soils), or on some dry pasture, where they remain till about three o'clock; they then return to the fold to a fresh piece of turnips and a bait of chaff. This system of management continues till lambing-time, after which the ewes and lambs are generally put on rye, and then on the layers, which carry them through the summer. The custom of night-folding the breeding-flock is general.

2nd Year, Barley.—As the turnips are cleared off, the land is ploughed for barley. Some farmers give only one earth, others two, ploughing first very fleet, and deeper the next time, by that means the droppings of the sheep are well incorporated with the soil, and others again scarify or ribble after the fold, and drill the barley on one earth; the plan of ploughing fleet and subsoiling has been adopted by some. The barley (Chevalier or Long-eared Nottingham) is usually drilled at the rate of about 3 bushels

per acre, distance of rows from 4½ to 8 inches; rape-cake is sometimes drilled with barley, or sown broadcast before the last ploughing. On one farm 2 bushels of seed, and sometimes less, have been drilled at 4½ inches, generally producing a better crop than the larger quantity. It is generally found that the early-sown barley produces the best crop, and hence the advantage of clearing off the turnip-crop as early as possible.

Wheat has been substituted for barley of late years on some farms after beet and carrots, and after turnips that have been fed off early. Very few good crops are secured by this method after turnips; I have seen better crops after carrots carted off the land than where the turnips have been folded. On the very light soils rye is sometimes grown instead of barley, particularly where the turnips have been fed early. Some farmers *prefer* rye after turnips. The manner of harvesting barley differs from that of the heavy-land districts. When fit for carting, the swaths are gathered into shocks with a shack-fork, (figs. *a* and *b*). In gathering corn with a shack-fork three swaths are laid in one row. The workman proceeds by pushing the corn with his fork till he has it full; he now lays this on the middle swath. At the end of the field he turns back and gathers the swath on the other side of the shock, the method of doing this will be better shown by the following diagram.





The swaths *a a a a* are gathered and laid on those marked *b b;* the intervals *c c c c* are also gathered, and in this manner the shocks *d*, as they are here called, are formed ready for pitching on the waggons. But previous to this the spaces between the shocks are raked with a horse-rake.

3rd Year, Seeds.—The small seeds are by some sown at the same time as the barley; by others after the barley appears above ground. There is more difficulty of securing a plant by the latter method; but there is no fear of spoiling the barley by the seeds getting too forward. The manner of sowing is either with a wide broadcast drill or with the hand; the quantity sown about 1 peck of red clover, 1¼ trefoil, ¾ peck of white clover, and 3 to 4 bushels of sainfoin respectively. Rye-grass is frequently sown mixed with clover and trefoil.

Mr. R. Raynbird, of Hengrave, sows seeds (clover, sainfoin, and rye-grass) in the following manner. Instead of the usual

practice of sowing broadcast, the plan of drilling small seeds with a light one-horse drill has been adopted:—This is not done till after the corn has come up, sometimes it is even 4 or 5 inches high; the drill is followed by a light gang of harrows, which complete the operation by covering in the seed after the drill. The land is drilled and harrowed across the rows of corn, the distance between the seed-coulters $4\frac{1}{2}$ inches. Independently of securing a good plant, the benefit derived from the destruction of weeds, the loosening the soil, and breaking the surface-crust amply repays the extra expense. The harrowing may appear to be injurious by pulling up a few blades of corn; but the benefit to the crop is visible a few days after. On very poor land the seeds, trefoil and rye-grass, are allowed to remain two years, and sainfoin sometimes for four years; the latter is perhaps one of the best crops that can be grown on the light soils, and by laying the land down for four years it makes no break in the rotation. As a substitute for clover sainfoin is sometimes sown, and the following year ploughed up for wheat: it is generally believed that the 2nd and 3rd years' sainfoin is much better than the 1st, but very abundant crops of hay are produced by letting it lie one year, and it is a good preparation for wheat. However, on land of inferior quality, sainfoin is undoubtedly more profitable if allowed to remain four years. Sainfoin should be mown the first year, and then fed with lambs, for if fed with sheep they injure the plant by biting off the crown.

The layers are chiefly fed off with sheep, though a portion is mown for hay, and a portion is also occasionally seeded.

On the very poor soils the sheep have the whole field to feed upon at once, but upon soils of a better description the layers are frequently hurdled off with fatting sheep early in the season, oil-cake, corn, and mangel-wurzel being given in addition to the clover or grass. Sheep are regularly night-folded on the layers through the summer and autumn; upon the inferior soils folding is the principal preparation for wheat.

Management of Sainfoin for Seed.—Land rolled in the spring, and the stones picked the same as for a hay-crop. The seed-crop is usually fit to cut about the beginning of July, but the time varies with the season; this as well as all other seed-crops of the same species of plant is best cut either early in the morning or late in the evening, as the seed is much more liable to brush off the stalk during the heat of the day than during the cool and dampness of the mornings and evenings. The mowers will rest during the worst time for hard labour. Two or three days after cutting, the seed may be turned, and, should it continue fine weather, the crop will be fit to cart in six or seven days. In unfavourable weather the swaths will of course require lifting and

turning. On the morning of carting the swaths are gathered into rows sufficiently far apart to allow the passage of a cart or waggon, a horse or hand rake being first used in the intervals. The gathering should be completed before the sun bears much power, or much of the seed will be brushed out in the act of moving the swaths. As soon as the sainfoin is dry the carters may be set to work, but care must be taken to handle the seed as carefully as possible, or some loss will be sustained. The seed is said to keep best in the stack. The stalks appear rough and sticky, but if cut into short chaff they will make useful provender, and many farmers consider it equal to hay.

Italian rye-grass is grown instead of clover on some of the better soils, and has produced very abundant crops,—the quantity sown per acre is about 2 bushels. A description of the plan followed by some farmers in harvesting this crop may perhaps be interesting from its novelty.

Italian rye-grass for a seed-crop requires to be cut before it becomes perfectly ripe, for if allowed to stand too long the greater portion of the seed will be blown out by the wind. When the seed is ripe—this may be known by examining the heads and seeing that the seed is perfectly formed—it is mown early in the morning, for when damp the seed does not shake out so much as it does in the heat of the middle part of the day. When the mowing is finished, should any docks or thistles, or any other large weeds be observed in the swath, they may be picked out by women and children; this will tend in some measure to secure a good and genuine sample of seed, the sowing of which will not produce a crop of weeds upon the land. The next day after mowing, as early in the morning as it can be conveniently done, the grass is tied up in sheaves in the same manner as wheat, and then placed four sheaves in a shock. By adopting the practice of tying, comparatively slight loss of seed is occasioned by the operation of getting together and carting. The straw must also be more valuable than when exposed to the full action of the sun and wind. The seed will be fit to thrash in a week or ten days from the time of cutting; but this of course depends upon the weather. It may also be carted sooner if thrashed in the field at once than it can be if stacked or carried in bulk to the barn; for if at all green this kind of grass is very likely to heat, and thus spoil the seed. A hot, dry, calm day ought to be selected for thrashing the seed in the field, and a smooth piece of ground may be selected for the thrashing-floor in the centre of the piece. Four or five thrashers may be kept at work by having a horse and a light cart with a cloth laid across it to prevent the shed seed being lost. A man and a boy carting with one horse will keep four or five thrashers at work.

The rye-grass straw may be stacked up immediately after thrashing, and, if it is not made too much, it will be pretty good hay.

The seed will require to be spread thinly over a floor and frequently turned with a shovel to prevent heating, and on hot days it must be laid on a rick-cloth in the sun: this will require to be repeated several times before it is fit to put away in sacks.

When seeds fail, which is often the case on the poor soils, the land is ploughed up and sown with peas. Occasionally the barley is not seeded, and then peas or tares are grown after the barley; the tares are either fed or seeded; if fed, followed by cole-seed also fed.

4th Year, Wheat.—The preparation for wheat is claying, dunging, or folding. Some apply the greater portion of their farm-yard dung to the root-crops, considering that, if a good root-crop is secured, it will be the means of laying a foundation for the succeeding crops. The process of claying will hereafter be described. The dung is usually carted out of the yards on to a bottom of mould or clay. After lying for some time it is turned over, the outside receiving a covering of earth. It is generally considered that the dung for wheat should be carted on clover land some time previous to the ploughing, so that the clover may grow through the coating of dung, as where manure has been ploughed in directly, the crop of wheat has been found to be inferior, but the reason it is difficult to imagine. The old layers are ploughed in September and October about 4 inches deep, with the furrows laid flat, and then rolled in the same direction as ploughed: the implement used for this purpose is usually the common drill-roll with three horses, or the common heavy roll. The time of sowing wheat is October and November, the quantity used about 2½ bushels per acre.* Previous to drilling, the seed is prepared by steeping in a solution of blue vitriol; the following recipe is very generally used and found effective:—Dissolve a pound of blue vitriol in a pail of boiling water, then add three pails of cold water and it is fit for use. Let the wheat be in the liquor ten minutes, during which time it should be stirred and skimmed; then strain it off through a skep over another tub, and in twelve hours it is fit for use. The wheat thus prepared is drilled either in the direction the land is ploughed in or across the stetches, the land being harrowed before and after the drill. A drill drawn by three horses sows about 10 acres in a day. Artificial manure, such as rape-cake, is frequently drilled with the

* A few farmers may use a smaller quantity of seed per acre, but the average of the light land would be nearly, if not quite, 2½ bushels. This quantity of seed may appear unnecessarily large; but it is required on the light soils, particularly where game is strictly preserved.

wheat, or sown before the plough when no farm-yard manure has been used. The plan of sowing the rape-cake before the plough is preferred to drilling it, because by the former method the manure is deposited further from the seed, it does not force the wheat early in the season, but in the spring when growth is desirable. The varieties of wheat chiefly cultivated are the Clovers Red, Marygold or Rattling Jack, and Spalding's Prolific —the latter is a very productive though rather coarse variety, which is very generally grown throughout the country, and owes its introduction to a labouring man named Spalding, who lived at Barningham in this county. Thirteen years ago Spalding, while thrashing in his master's (Mr. Wiseman's) barn found three or four particularly fine ears of wheat; these he had the foresight to pick out and plant in his garden; the next year he again sowed the produce, and the third year grew a quarter of an acre; he then sold his entire growth, which was sufficient to plant 10 acres—the produce of this was upwards of 8 quarters per acre. A small subscription was raised by the neighbouring farmers for Spalding; he died a few years since: there are still some of the family living at Barningham. Spalding has done as much for his country as many more public men; though unknown, he has had his *name* widely disseminated, though perhaps he did not reap any very great worldly benefit from his discovery.

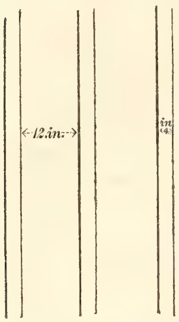
The Talavera wheat was largely grown a few years back with much success, but it has so deteriorated that it is not much cultivated at the present time.

The cultivation in the spring is that of light harrowing across the drills, usually obliquely, in the dry weather of March; this destroys the poppies and pulls up those weeds that cannot be cut with the hoe: the improved appearance of the wheat a few days after is very apparent. Soon after harrowing, the wheat is hand-hoed, and this hoeing repeated with weedings so late into the season as June, at a cost of 6*s*. per acre in all.

Some farmers use horse-hoes, with which they are able to hoe between drills only six inches apart. This consists of a wooden bar 8 feet long on wheels. The hoes, six in number, work on levers, not much unlike those of Garrett's horse-hoe, attached to this bar. The levers are separate, have universal joints, and handles to each. One man or boy steers two hoes, and a man leads the horse. The horse-hoe, in returning, hoes those drills where the hoers walked in the first bout. About six acres per day are hoed on 8-inch work. Rape-cake or nitrate of soda is sometimes used as a spring top-dressing.

Wide drilling with two rows close together is said to answer remarkably well on light land; by this plan wheat or peas are drilled in rows 4 inches apart, with a space of about 12 inches

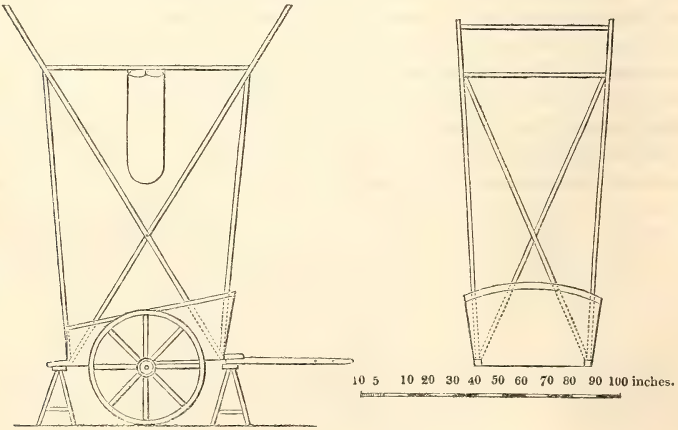
intervening between every two rows—thus. Of this method much may be said in its praise and dispraise. Scientific men tell us that light and air are essential to the production of a fruitful crop. Practice will also tell us that wide drills are well suited for horse-hoeing and stirring the soil during the growth of the crop. But on the other hand, in the wide drills there is much more space and air for weeds to vegetate and grow. And it is found on these poor soils, so favourable to the growth of weeds and so unfavourable to the growth of corn, that, should wet weather occur during the hoeing season, it is impossible to eradicate the weeds.



Rye is grown on the very poor soils instead of wheat, a proportion of which is thrashed out during harvest, for which there is always a demand for the purpose of being sown for green food in the spring.

The practice of mowing wheat is on the increase; it is a practice that cannot be too much commended, particularly for harvesting the light-strawed crops of this district. The manner of putting out harvest-work adopted in the western sand district will be found described in the 'Essay on Piece-work,' vol. vii. p. 119 of the Society's Journal.

Stacking-stages are used by many farmers; one of the most convenient is a frame fitted into a cart, which admits of removal from one stack to another with great facility: the advantage of this stage is the convenience to the men unloading when the stack gets beyond a certain height; it also saves the shelled corn,



which either falls through holes into the cart or into a sack hung on hooks.

The frame is fitted into a cart in a short time, and when harvest is ended it is removed from the cart and laid up ready for another season.

Made of larch-poles the cost for materials and workmanship is under 3*l.*

The management of manures demands some attention. In the heavy-land district the term "muck and manner" signifies a compost formed of earth dug from borders, the scouring of ditches, and other soil, which have been removed to form a bottom for the farm-yard manure; where it can be conveniently obtained, chalk is used by some for this purpose. The manure is carted from the yards principally from Christmas to June, and either thrown from the carts on these heaps of soil, or the carts are drawn on the hill and unloaded by kicking up. By the first method fermentation commences immediately, the manure quickly becomes rotten, and there is consequently a great loss of bulk; by the latter very little heat arises, the pressure of the carts causing the manure to keep as free from change as if it was still trodden by the cattle in the yards. Two turnings are frequently given, by which the manure and heavy stuff become mixed; a portion of the earth is laid on the outside of the heap to prevent waste and the escape of gases. Manure fresh from the yards is used by some farmers for roots: those who object to this system say that unprepared dung does not so readily decompose in a stiff soil as it does in a light one.

Great loss of bulk is undoubtedly sustained by the method of preparing dung that is frequently adopted; and this loss, being occasioned by the escape of vapour and fluid, no doubt causes some loss in the fertilizing power of the manure. Compost, formed in the proportion of 10 loads of heavy stuff to 20 loads of dung, leaves from 20 to 25 loads when applied to the land; this is reckoned by some who do not manure for roots as a dressing for an acre of land for wheat. It is a question not yet agreed upon by the Suffolk farmers, whether the manure should be applied for green crops or for wheat; the latter on the heavy land is frequently too bulky a crop, and is consequently laid, and therefore one would imagine the manure is best for the green crop, which can never be too heavy. Manure throughout is chiefly manufactured in yards.

Cattle are generally bought in lean in the autumn, fed on white turnips, then swedes, and afterwards beet, with corn and cake or compound, and sold fat from February to June. Cattle are chiefly grazed in yards, the polled home-bred; and Galloway Scots are considered to be the best, from their quiet nature, for open yards, though short-horns are very often fatted. Though

loose throughout the day, the cattle are usually tied up to the trough while eating their bait of meal or oil-cake.

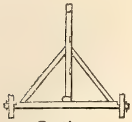
Mr. Edwards, of Wickham Skeith, as well as some other farmers, fats bullocks and hogs in the same yard—a small place being partitioned off for the hogs to go under and feed. The bullocks do not appear to be at all disturbed by the pigs, nor the pigs inconvenienced by the bullocks. This is perhaps one advantage that hornless breeds have over others for fatting in yards, for they are generally more peaceable among themselves and also with other animals. The advantages of having pigs kept with bullocks are that no loss of food is sustained, for they not only eat the food thrown down by the cattle, but also (particularly if the cattle are corn or cake fed) in a great measure consume that which has already passed through the cattle. It is thus exposed to the digestive organs of two distinct kinds of animals; and we may take it for granted that all the fat or flesh forming principles are by that means extracted. The routing of the pigs in the litter shortens the manure, and they also increase its value by the mixture of different excrements.

Farm Horses.—The manner of stabling horses is very different from that of other parts of the country; the horses are merely baited in the stables with oats or beans (crushed) mixed with wheat and barley chaff or cut hay, and in the night are turned out into yards to which a good open shed is attached—in this are troughs and racks filled in winter with hay or fresh barley-straw. In summer the system is that of soiling in the yards, principally with tares, though lucerne, clover, Italian rye-grass, and common meadow-grass are also given. Some are still in the habit of turning their horses out to collect their own food; the disadvantage of the latter plan is obvious enough—it occasions a waste of food, and a horse does not require exercise after a hard day's work. Much may be said on both sides in favour of yard or stable management; however, the Suffolk horses turned out into yards throughout the year are not exposed to extremes of heat and cold, seldom suffer from grease, and are I believe more free from disease than those kept entirely in stables.

Sheep.—The greater part of the heavy land of Suffolk is not suited to folding sheep, though fatting and breeding sheep are kept by some farmers. Earth-drains are liable to be injured in the common method of hurdling by the shepherd striking his fold-drift into the drains; consequently hurdles on wheels or feet, either of wood or iron, are used by many: these appear equally adapted for light-land folding.

Mr. Harvey Denny, of Mendham, Suffolk, has had a fold of this description in use for fourteen years, and the hurdles are now in very good repair. Mr. Denny's hurdles, of which I have

given a sketch, are 18 and 21 feet long, on four iron wheels; the axles of the wheels are one yard long. If the wheels were closer, the hurdles would blow over.



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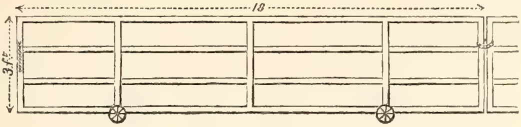

An 18-foot hurdle is made from a 21-foot deal, costing 10*s*. 6*d*., four wheels 3*s*., making altogether something less than 20*s*. for each hurdle. The fold is set in a quarter of an hour by a boy; or if on a fallow where the soil is loose, a horse is hung on and draws one side of the fold at once. Mr. Denny says the advantages of these hurdles over those commonly used are their durability, their little trouble in removal, particularly on hard land; they are not so liable to blow down, which common hurdles frequently do on light hilly land similar to his farm. Strongly as he recommends these, yet he would prefer iron hurdles on wheels: these are used by farmers in the neighbourhood of Mendham: some are made with iron rods between the top and bottom rails.

On asking the cost of hurdles of this description in the neighbourhood of Stowmarket I was told 16*s*. each; these were made of larch poles sawn in two, 20 feet in length, with four iron wheels.

Breeding sheep are chiefly a cross between the Down and old Norfolk. Grazing sheep—half-bred Leicesters are preferred—are bought in the autumn, and sold fat from March to June.

Some farmers throughout the winter feed their sheep during the day on pasture-land, carting turnips for them from arable land, and in the night drive them into a yard; by this management the injury done by treading the land is prevented, and a good yard of manure accumulates during the winter months.

Farmers who feed their sheep on pastures and then drive them to fold on arable land are often of opinion that grass-land is injured by sheep.

I find it is the opinion of a good practical farmer who folds on grass-land that he has greatly improved his heavy-land pastures by that means. As affording a valuable supply of spring food the following practice may be worth mentioning, and it is not the worse for being an old system strongly recommended by A. Young. A portion of the pastures are not fed in the autumn, or the aftermath, after the hay has been made, is shut up through the winter;

this is folded off in the spring with ewes and lambs, the lambs being allowed access to the fresh grass at the head of the fold. Tares afford feed during the early part of summer to some flocks.

A considerable portion of pasture-land has of late been converted into arable, the manner of breaking up is by paring (breast-ploughing) and burning in the spring at a cost of from 25*s.* to 30*s.* per acre. The flags are burnt in small heaps and the ashes are spread on the land; some, to save fuel, burn in one or two large heaps. Coleworts, white turnips, or swedes are taken the first year, then oats, and (by some) wheat the third year, which cannot be good management, though some take peas the third year and then wheat, and then the usual rotation. The land is drained the first or second year after breaking up if it requires it. Clay or heavy stuff is laid on new land, but this will be described under the head of marling.

Nothing of any moment has been said concerning pasture, nor do I think that the subject demands that much should be said. Under our present system of managing grass-land and the increasing labouring population, I question whether there is any great quantity (with the exception of marsh) that would not be better broken up. A certain proportion of grass-land is undoubtedly required on every farm where stock is kept, but speaking generally of Suffolk it ought to be a small proportion.

Among the notes which were taken in my journey round the county the following are the only ones relating to grass-land worth mentioning. With respect to low-lying meadows one farmer says he has made great improvement in the quality of the grass by carting on road-scrapings, after the application of which the rushes and sedges disappeared. Thistles abound on a good deal of the grass-land, and attempts are made to extirpate them by mowing off when grown to some height. Mr. Bond, of Hacheston, says they may be destroyed in three or four years by spudding up when young.

3. *The Improvements effected in the Farming of Suffolk since the Report of Arthur Young in* 1804.

I am indebted for the following description of the improvements since the time of Arthur Young, to Mr. Rodwell, of Alderton Hall,—a gentleman whose well-known experience gives the greater weight to the excellent remarks he has made on the subject:—

"*Improvements in the Farming of Suffolk since the Report of Arthur Young.*

"To our greatly revered countryman we must give the well-deserved

and well-earned fame that has ever attached to his habits of industry, perseverance, and foresight, his first object amidst his inquiries being to induce farmers to lay aside their deep-rooted prejudices, and thus, as he has often expressed it to me, 'to make the farmers *think* for themselves;' and that he accomplished this to a great extent the improvements that have gone on progressively since his time are indisputable evidence; but to make any deductions as to the exact measure of such a result could be effected only by collecting the statistics of corn and cattle annually produced in our county now as compared with what it was in the last century, and the comparative cost of such production. This, however, is not an easy task; but a fair test might be taken from the advance of rents, which, of course, must be some index, as they can only be raised by an increase of production at a diminution of expense. This, therefore, would give a *result of* 100 *per cent.* upon the average of this county.

"If, however, we take our data on the above head by the systems pursued by the present race of farmers in the details of management, it would lead us into a wide field—too wide, I fear, for the object of your inquiry. There is, however, one subject which I think demands our especial remark, which is the greater care and improved management of manures, not only by enlarging the quantity by the increase of stall-feeding cattle and various other plans, but in the better application of it when obtained.

"We have also a fresh stimulus in draining, and in the more frequent use of clay, chalk, &c., as top-dressing on soils to which they are adapted; but they are to be mentioned rather as a continuation of systems adopted formerly than of modern introduction.

"Then we have also great improvements made in the introduction of new roots for general purposes, and amongst them we may rank the Belgian carrot. Then also of seeds, grasses, &c.; and in this class we must not omit to notice the greatly increased production from the growth of Italian rye-grass (*Lolium Italicum*), under which head one of the most intelligent agriculturists in the county of Nottingham, Mr. Parkinson, says by the introduction of Italian rye-grass he doubled the quantity of cattle on the same occupation, both in rearing and summer fatting.

"To enumerate all the improvements and aids given to our pursuit by the science and perseverance of the justly renowned machine-makers of this county would be a work of supererogation, for the names of Ransome, Garrett, Smith, &c., are already too well known to need any comment. It would, however, be only giving a just tribute to the long established fame of the Leiston Iron Works if we were to acknowledge the debt which our county owes to its firm for having brought to an unrivalled perfection its *drills*, its *horse-hoes*, and more especially its threshing-machines, as their prizes will amply testify, not only at the meetings of our National Society, but throughout the provinces."

In addition to the mportant improvements alluded to by Mr. Rodwell we may mention the superior cultivation of mangold-wurzel (this root is not mentioned in the report of Arthur Young,

and therefore we may conclude it was very little if at all cultivated) and other root-crops.

The Improvement in the Breed of Horses, Sheep, and Cattle.—Suffolk has long stood pre-eminent for its breed of horses, and the unvaried success it has had in carrying off the prizes at the Society's shows sufficiently proves that the Suffolk horses have not deteriorated in their value as the *best* for agricultural purposes. At five out of the eight meetings which the Society has held, viz. at Oxford, Liverpool, Southampton, Shrewsbury, and Newcastle, the Suffolk cart-stallions have won the first premiums. At the Cambridge meeting a Suffolk cart-mare and foal, and a horse, bred by a Suffolk farmer, *won the first prizes.* At the Derby and Bristol meetings I believe none of the Suffolk breed were exhibited. The fact of Suffolk beating all England for six years out of eight must convince the public, if that were now needed, of the invaluable properties of the Suffolk Cart-Horse.

Suffolk cows, so noted for their milking properties, are still the most general dairy-breed in the county; but the Suffolk farmers wisely depend on other counties for cattle for grazing purposes, and it may be truly said that the Suffolk farmers of the present day are better feeders than breeders of cattle. But it is in the breed of sheep that the greatest improvement has taken place. The restless Norfolk is now rarely seen, their place being taken by the Southdown, or by the cross between that breed and the old Norfolk—a breed equally hardy, with greater fattening properties than the old Norfolk, though not in the latter respect equal to the first cross between the Leicester and Down, which cross in Norfolk and Suffolk is the favourite for grazing. If we except Mr. Jonas Webb's incomparable flock, some of the South down sheep bred in Suffolk will challenge competition with the best in the kingdom.

Great improvement has been made by converting pasture into arable land by the bringing into tillage a considerable extent of heath-land, on much of which good crops are now grown; by the use of artificial manures; and, in a word, the general management of all descriptions of land may be considered as greatly improved.

4. *The Antiquity and Extent of Thorough-Draining within the County.*

Evidence has already been collected on the antiquity of draining in this part of the country, which leaves but little to be said concerning it, and reference to works already published, more particularly to the article of the Rev. Copinger Hill, of Buxhall, in the Society's Journal, will give ample information both as to the antiquity and extent of thorough-draining. That the practice

of draining can be traced to the early part of the seventeenth century is a fact well authenticated by many writers on the subject.

Much of the heavy land of Suffolk has been repeatedly drained, though, from inquiries which have been made in various parts of the county, the system of close-draining has never been carried to a *greater* extent than it is at the present time; that it has been progressively on the increase is shown by the statements of old farmers, who allege that sixty or seventy years ago the practice was just being introduced into the parish in which they had been brought up, and that previous to that time the system of *thorough* draining by placing drains at regular and close intervals throughout a whole field was not practised, but merely drains put in here and there to carry the water from a particular wet spot.

The extent to which draining is carried is well authenticated by the statement that *throughout* the entire heavy land of Suffolk there are *very few* arable fields in which drains are not to be found.

The following list of the quantity of draining done by the successful competitors for the prize of 4*l.* offered by the West Suffolk Agricultural Society, will be a proof of the extent to which draining has been carried by the modern race of tenant-farmers. I have to thank Mr. Beeton, the secretary, for this information.

The conditions for competition for this prize are—

"To the tenant who shall have spade-drained within the last twelve months the greatest number of rods in a husbandlike manner, relative to the extent of his occupation."

These conditions were altered in 1838.

To the tenant who shall have expended the largest sum in spade-draining within the last twelve months relative to the extent of *wet land* in his occupation:—

		Rods.		Acres.
1833.	Mr. John Rollinson, of Rede, drained	4000	Occupation	150
1835.	— George Doel	7520	„	150
1836.	— James Lee, Whepstead . .	6435	„	300
1837.	— James Lee	4059		
1838.	— John Simpson, Wyken Hall .	5858	(Wet land)	275
1839.	— John Boldero, Rattlesden .	$7039\frac{1}{2}$	„	330
1840.	— John Boldero	7010	„	330
1841.	— John Simpson, Wyken Hall .	5125	„	275
1842.	— R. B. Harvey, *Norfolk.*			
1843.	— James King, Felsham . . .	4016	„	150
1844.	— J. S. Flowerden, Hinderclay .	7105	(Wet land)	120
1846.	— H. Lugar, Hengrave . . .	2415	(Wet land)	150

I have also to thank Mr. Manning Keer, the Secretary of the East Suffolk Agricultural Association, for a list of the successful competitors for the draining prize to the tenant who should drain

the most during the last twelve months without any assistance from his landlord.

		Rods.	Occupation. Acres.
1840.	Mr. Robert Foulsham	7243	235
1841.	— Francis Skoulding, of Kelsale . . .	8689	270
1842.	— Francis Skoulding, of Kelsale . . .	6725	270
1843.	— Francis Skoulding, of Kelsale . . .	4805	270
1844.	— Samuel C. Goodwyn, of Huntingfield	6064	334
1845.	— Charles Smith, of Sweffling . . .	1149	342
1846.	— George Edwards, of Monk Soham	11,395	290
1847.	— Henry Moore, of Badingham . . .	9075	279

I extract the following note from Sir John Cullum's 'History of Hawstead, in Suffolk' (1780) :—

"The greatest improvement of which this strong soil is capable is draining. The drains cut with curious tools made on purpose are about two feet deep, wedge-shaped, and fitted at bottom with bushes, and over them with haulm. Six or seven score rods are cut upon an acre at a cost for cutting of 2*d.* a rod."

"The difficulty of discovering the antiquity of thorough-draining arises from its being by old writers confounded with spring drainage. This latter was practised even by the Romans with drains 3 feet broad at top, 4 feet deep, and 1¼ foot wide at bottom, filled half full of stones, or the bottom was made narrow and a rope of twigs fitted to it."—*London Ency. Agricult.*, 1831, p. 27.

To return to Suffolk thorough-draining. In the Suffolk Report it is said that Mr. Makyns, of this county, was about twenty years ago (1770) rewarded by the Society of Arts for a plough for cutting these drains, but that it had been laid aside as more expensive than hand-labour. James Young, Esq., of Clare, also describes the method then common in that vicinity, which was exactly the same as that still practised. He mentions a field drained in 1773 which had every drain in the field (except one) running in April, 1786. He drained 30 inches deep, using the plough for the first 14 inches to 20 inches; put eight score rods on an acre, and paid for digging only 1*s.* 8*d.* per score rods, for filling with stubble 4*d.* per score rods.

The following extracts from a book printed 120 years ago, styled 'A complete Body of Husbandry, collected from the Practice and Experience of the most considerable Farmers in Britain; particularly setting forth the various Ways of improving Land by *hollow-ditching, draining*,' &c., by R. Bradley, Professor of Botany in the University of Cambridge, F.R.S., 1727, will be additional evidence as to the antiquity of thorough-draining in Suffolk. Professor Bradley mentions hollow-ditching or draining as lately invented, and introduced to the North of Essex; and therefore we may take it for granted the same system of draining was adopted at that time on the adjoining wet land of Suffolk. It would take up a considerable space to extract the whole of Bradley's description of *hollow-ditching*, though I shall give sufficient to show that the system then adopted resembles the present practice, the latter being an improvement on the old method of draining:—

"These drains, whether they be the great or small ones, must be made two full spits of a spade deep and half a spit, sloping on each side from near three feet wide at the top to about half a foot at the bottom, and then some large rough stones or cows' horns * laid at the bottom for the water to run through, with some straw over them; or else a few boughs of elm, white-thorn, or hawthorn rammed into the bottom, and straw laid over them, and then covered with the earth that was dug out. When all are completed and settled, then you may plough the piece and dispose it equally on such a level as it will bear. This method is accounted the best and cheapest way of hollow-ditching or draining, and will make the wettest squally land fit to bring very good corn, or to be laid down for grass, or other uses. The common price for digging and laying the stones or bushes and filling up the drains is about twopence halfpenny or threepence a rod in length, but the owner or possessor of the ground must find bushes and straw, which, together with the digging and laying, will amount to about sixpence a rod. A large field, I confess, will amount to some money, as suppose there may be required one thousand rods of this work to drain twenty acres, the expense at sixpence per rod will be twenty-five pounds, or after the rate of one pound five shillings for the improvement of each acre, which is but a trifle considering that the ground before was neither good for bearing corn or grass, and will now bring good crops of any kind. This improvement is chiefly practised in Essex; I have seen it at Navestock, in the forest, at an estate belonging to Aaron Harrington, Esq., and is lately brought from that part of the county to the north of Essex about Wicken-Benant,† and near Sir Kane James's; and I doubt not but will be generally used upon all the squally wet grounds in England when it comes to be known, for it is *but a late invention:* only it is to be noted that the ground should lie sloping or declining one way or other to be mended by this means."

The prediction of Mr. Bradley that this improvement of wet land would become general shows that his work on husbandry was not much read by the farmers of the eighteenth century; for if they had been of more studious habits they would, on trial of the practice, long ere this have seen the benefits of (what is generally considered to be the modern invention of) thorough-draining. That the system of which Bradley speaks is a thorough-draining system is proved by his mentioning the number of rods required on a given space, viz. 1000 rods on 20 acres, which being 50 rods to the acre will make the drains about three times the distance apart that they are at present in the eastern counties.

The term *thorough*-draining is perhaps derived from the old word "thorrow," which Bradley mentions as "a distinguishing character for a trench cut purposely for carrying off of water."

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* Mr. Hill in his article on Suffolk Draining (Journal, vol. iv. p. 31), mentions instances of old drains being found filled with bullocks' horns.

† Wicken-Benant or Bonhunt is a village in the north-west corner of Essex, $3\frac{1}{2}$ miles from the borders of Herts, $5\frac{1}{2}$ from those of Cambridgeshire, 11 from those of Suffolk, and 15 from Great Thurlow, Suffolk, where Mr. Jonas has shown thorough-draining to have been practised more than a century.

5. *The process of Marling and the Soils benefited thereby.*

The details of this very interesting and desirable practice in the husbandry of Suffolk have been described by many writers, among whom are the late Mr. Macro of Barrow, in the 'Annals of Agriculture,' and 'The Letter of Mr. Josiah Rodwell of Livermere to the Board of Agriculture,' in 1800, for which he was awarded their Gold Medal. This letter is to be found in the Report of their Proceedings, and in the 'Annals and Calendar' of Arthur Young.

By the process of marling I believe is to be understood what we in Suffolk denominate claying, and perhaps improperly so, for there is very little clay applied to the land that does not contain a large proportion of lime; and the general test as to the good quality of clay is the presence of small particles of chalk, or chalk-stones as they are here termed. Notwithstanding this, I have used the term claying, because it is so called in this county, and in order that I may not be misunderstood: but it must not be taken for granted that I mean real clay, but a mixture of clay and chalk, which ought properly to be termed marl.

The application of marl or clay may be said to be general both on heavy and light land. On heavy it is used on freshly broken-up pasture-land, and mixed with farm-yard manure in the formation of compost heaps. On light soils its application is of course more extended, as it is here that the great benefits are derived by the improvement in the mechanical texture of the soil.

The scouring of ditches on the heavy soil is carted to form bottoms for the farm-yard manure, with which it is mixed by turning, &c.

On freshly broken-up land, clay and other soil is carted on to the amount of from 40 to 50 cubic yards per acre. The benefit derived from this is the better quality of the grain, and regularity of the crop. New land, whether it is naturally of an adhesive and retentive nature, or dry and sandy, or light and loose peaty soil, is found to produce a patchy crop of a bad quality of grain, which is corrected in a great measure by the application of marly clay. The excess of organic matter in the heavy soil gives it a looseness of texture which the clay corrects: the dry and loose texture of the sand is rendered more adhesive and retentive of moisture, and the peat is benefited by consolidation, and the supply of inorganic matter.

In first beginning to marl or clay a field, if no pits have been begun beforehand, it is usual to ascertain where the best material can be most conveniently raised for carting. This is done by digging down to ascertain the subsoil, and frequently the marly clay is found within a foot of the surface. The soil is now

dug and filled into carts; the digging proceeds in a sloping direction downwards, so as to form a mouth to the pit of a gradual descent, for if very steep the horses are liable to be strained in drawing the loaded carts from the pit. As soon as a sufficient depth is obtained the plan of operations is altered; for instead of picking and digging they now proceed to make what are termed "falls," in a manner that is well known to all excavators: this is done by picking or undermining at the bottom for a sufficient distance along the side, and at the extremities of the undermined part, a perpendicular crevice is picked out from the top to the bottom. This having been completed, clay wedges shod with iron are driven in at top with a heavy mallet or beetle, and this being continued for a short time the clay splits down perpendicularly. In this manner as much soil is "raised" as will be filled into carts by three men in a day's work. Men employed in filling usually "raise" (if falling down may be called raising) the clay when the horses are resting, or after they have left off for the day.

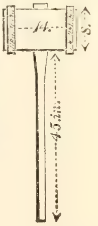


Fig. 1. Clay beetle, with iron hoops $1\frac{1}{4}$ inch diameter put on with nails; made of tough elm; the handle of ash. This is a clumsy and heavy tool, but not more so than is required to drive the wedges.

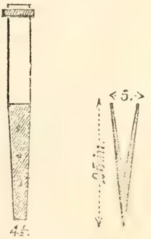


Fig. 2. Clay wedge, 45 inches long, 5 inches diameter at top, with $1\frac{1}{2}$-inch iron ring round it. Iron part of wedge (shaded in the drawing) riveted through the wood.

The labour of filling clay is generally paid for by the cubic yard or load: for filling and spreading from $2\frac{1}{2}d.$ to $3d.$ per yard is paid. The work is sometimes done by men who contract at so much a yard (measuring the pit when the work is done) for filling, spreading, and carting, finding carts and horses: the price is about $7d.$ per yard if carted one furlong, $1d.$ being added for every additional furlong, but this has been already described in the report on Measure Work. Ten yards a-day is reckoned a fair day's work for one man.

The season generally chosen for carting is during the winter on fallows, and occasionally on layers; clay is carted at any period of the year for bottoms of manure heaps.

Carting clay or marl is an operation that will afford ample employment during the frost of winter, and it can then be done with the least injury to the land. When carted in the winter, it is exposed to the frost, by the action of which the hardest clods are broken. Spreading should be done as soon as possible after carting, because in the event of wet weather this becomes a trouble-

some operation from the clay sticking to the shovel, and also from its becoming consolidated in the heaps.

After being spread, the stones, of which there are often a great many, are picked from the land, and the clay pulverized during dry weather by harrowings and rollings. Some employ people to break the clods by manual labour; but this can be done much more effectually by Crosskill's clod-roller.

The clay is ploughed in shallow; the next ploughing deeper, so as to bring it again nearly to the surface. Many prefer claying on clover layers; and when it is dry weather there is no better time for laying on clay than during the few weeks preceding harvest. It is then dry, and can easily be pulverized, and the furrow for wheat is always a shallow one; the clay is well mixed up with the soil by the deeper fallow ploughings.

The quantity usually laid on per acre is from 30 to 40 cubic yards; though a much greater quantity is frequently applied to fresh broken-up heath lands.

To show the extent to which the admixture of the subsoil with the surface is carried by the tenant farmers of this county, I give the following list of the successful candidates for the premium of 4*l.*, offered by the West Suffolk Agricultural Association, with the number of chaldron loads (36 bushels) spread by each farmer, with the extent of his light or fen-land occupation. For this information I am indebted to Mr. George Beeton, the Secretary.

The conditions of competition for this prize are—" A premium of 4*l.* to the tenant who shall have carried and spread the greatest number of chaldron loads of clay, loam, or marsh-earth, within the last twelve months, according to the relative proportion of arable land in his occupation." During the latter meetings this rule has been altered to the relative proportions of light land in the tenants' occupation.

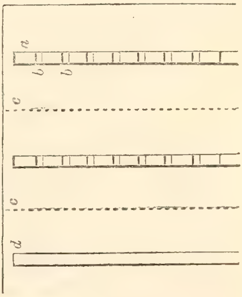
		Loads.		Acres.
1834.	Mr. John Rollinson, of Rede, clayed with	1245	Occupation	150
1835.	— James Lee, Whepstead . .	1679	,,	300
1836.	— James Lee	1145	,,	300
1837.	— James Lee	1512	,,	300
1838.	— George Gayford, Rymer . .	2556	,,	500
1839.	— George Gayford . . .	8485	(Fen land)	160
1840.	— John Boldero	1730	,,	330
1841.	— Edward Witt, Fornham . .	6776	(Fen land)	215
1842.	— Edward Witt	10,286	(Fen land)	215
1843.	— Edward Witt	14,590	(Fen land)	215
1844.	— George Gayford . . .	4513	,,	500
	— Edward Witt	8876	(Fen land)	215
1845.	— Edward Witt	9325	(Fen land)	215
1846.	— James King, Felsham . .	1066	,,	150

For a prize of the same amount offered to tenant farmers only, by the East Suffolk Agricultural Association, we have—

	Loads.		Acres.
1841. Stephen Oxborough, Capel . . .	3540	Occupation	1600
1842. Thomas Freeman, Henham . . .	1542	„	400

In the fen district clay is used to a large extent, and with considerable benefit: it consolidates the loose peaty soil, by supplying inorganic matter to the vegetable material of the peat, and consequently it produces grain of a better quality and stiffer straw, the clay is dug in holes or trenches, and is not such expensive work as claying light sandy land, where the clay has to be carted to a considerable distance.

Mr. E. Witt, of Fornham, whose name appears so frequently in this list of successful candidates for the prize of claying, has favoured me with an account of his method of claying on his farm in burnt fen, by which plan, during the six years he has held the farm he has dug and spread 51,798 loads (of 24 bushels) on 183 acres of arable land, at an expense, the whole being manual labour, of 463*l.* 6*s.* 9½*d.*; besides having levelled hills by carting and barrowing, and carted ditch stuff on the same land to the estimated quantity of nearly as much more. Very few instances of the admixture of the subsoil with the surface in so short a time will be found to equal this; by this means he has completely altered the nature and appearance of the soil, has given employment to a great many labourers, and made a permanent improvement for which he will be amply recompensed by the increased quantity and quality of grain grown. The fields being full of hills and holes produced irregular crops; but by removing the hills, and carting them on the black peat of the low parts, the surface has been levelled, and the fields now produce even crops.



The manner of claying is as follows:—Two furrows (*d*) are opened across the field, at intervals of two rods asunder; a man begins at one end of these and digs a hole (*a*) about 3 feet wide by 6 feet long; when he reaches the clay he does not dig down perpendicularly, but undermines a little, and throws out two loads of clay (24 bushels each), one on each side of the hole; he then digs holes similar to the first all the way up the furrow, leaving a narrow space (*b b*) between each to stop the water from running into the hole he is digging, as well as prevent the sides falling in.

The peat dug from each hole being thrown into the preceding one, he thus partly fills up the holes as he proceeds. The clay, being thrown out on each side of the hole, is spread up to a mark made with the foot across the field, midway between each row of

heaps, as at "*c*." The peat varies in depth from 2 to 8 feet; the cost for digging and throwing out is about 3*d*. or 4*d*. per hole; or if the peat is very deep, from 6*d*. to 8*d*.; the cost of spreading 10*d*. per score holes.

To complete the process of filling up the trench, a deep furrow is ploughed in on each side, the horses going at length. After the land has been ploughed once or twice across the trenches it becomes perfectly level.

Fen land works much better after being clayed, as the soil does not adhere to the plough. The land should be clean before it is clayed, as that operation is more difficult to perform afterwards; besides, the more the land is stirred the more rapidly will the clay sink into the subsoil.

The following is a list of the number of loads dug and spread by this method on Mr. Witt's fen farm since 1841:—

Fields.	Loads.	Per Acre.	Total Cost.
13 acres . . .	3,372	£2 12 9	£31 6 0
14 " . . .	3,430	3 12 0	50 8 2½
15 " . . .	3,990	2 15 1¼	41 6 8½
11 " . . .	3,082	2 6 10½	25 13 8
6 & 14 . . .	480	. .	4 4 9
21 " . . .	7,622	3 18 9	81 14 2
10 " . . .	2,962	2 6 2	23 1 8
8 " . . .	2,198	2 0 0	16 0 6½
	200	. .	1 9 8
4 " . . .	1,200	2 9 6	9 17 6
22 " . . .	6,718	2 16 10	62 9 5½
	256	. .	2 8 0
6 " . . .	970	1 5 4	8 12 4½
	134	. .	0 16 9
1¼ " . . .	370	0 16 0	4 0 0
10 " . . .	3,172 }	4 0 0	40 0 0
Hills carried away	5,140 }		
4 " bank (strip)	1,286	2 10 0	10 0 0
17 " wash . .	4,452	2 10 0	42 10 0
3 " . . .	764	. .	6 7 4
183 0 13	51,798	. .	£463 6 9½

This averages 283 loads per acre, at a cost of 2*l*. 10*s*. 7*d*. per acre.

Crag.—A sandy mixture; calcareous from the quantity of shells it contains,—found in most of the parishes extending from Dunwich to the Orwell; it has been used as a manure to a considerable extent.

According to "Kirby," Mr. E. Edwards, a farmer of Levington, in 1718, accidentally discovered the use of this crag or shell. Being short of dung, he carried several loads of crag, and spread it over a part of a field, which to his surprise yielded a much

better crop than those parts which he had covered with dung. The origin of its being used on the black heaths is pointed out by Captain Alexander, in his "Soils of East Suffolk," and thence copied in the Journal, vol. iii. p. 183.

Of the use of crag as a manure, Mr. Rodwell says:—"The dimensions and great antiquity of the crag pits of East Suffolk, afford an indisputable proof of crag having been long used in these districts, and of its fertilizing properties, but more especially in rendering the stiff and retentive soils more friable and porous to the influence of atmospheric air. Upon these soils we find large quantities are usually carried, and in some cases repeated again and again with very good effect, at the rate of 30 or 40 cubic yards to the acre."

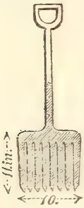
6. *The process of burning Clay, and the soils to which it is applicable.*

The practice of burning the soil dug from the borders of fields is very general in the heavy land of Suffolk: borders round the fallows are usually dug up in March, and the flags placed on their ends to dry. The scourings of ditches are burnt by some; these are either dug or ploughed up, so that they become dry; and are carted to the fire as wanted, or laid in heaps round the fire. The fire is prepared with straw, 3 or 4 faggots and blocks of wood, round which a wall of flags is formed; some mould is laid on, and the fire is lighted on the windward side; the flags are chopped in pieces before being laid on. Very little is laid on at first; but after a few days the heap requires constant attendance, because, if suffered to burn through, the fire is likely to go out; fresh clay must therefore be laid on 3 or 4 times a-day. Before letting out the fire the side walls are drawn and the unburnt flags are cut in pieces and burnt. The great art consists in applying fresh material as soon as the fire makes its appearance on the outside.

The cost for labour is from 8*d.* to 1*s.* per chaldron load (36 bushels); the burnt earth is used on fallows at the rate of from 15 to 30 loads per acre. It is also drilled with turnips, and a dressing of burnt earth is considered by some to be the best manure for clover. Border-burning being practised throughout the greater part of the heavy land district is a sufficient proof of its usefulness on that kind of soil.

But there is another system of burning practised, more especially in that part of the county lying between Stradbroke and Framlingham, viz., in Dennington, Worlingworth, Brundish, Baddingham, Laxfield, Cratfield, and the adjoining parishes. This is chiefly a deep staple soil. I obtained the following information at Stradbroke respecting "clod-burning," which is the name

given to this kind of burning. After the first thwarting of the fallow (cross-ploughing), and as soon as the land is dry, the clods are worked by harrowings and rollings into about the size of a hen's egg; these clods are raked into rows, and the accompanying drawing shows a fork which is used to gather the small clods into heaps ready for burning: the advantage of so many tines is, that the fork takes all the clods and leaves the dust. The tines are 1 inch wide, with ½ inch interstices.



The clods are burnt in small heaps, with haulm and bean-stalks, or furze brought from a distance. The burnt earth is then spread on the land and thwarted in (that is ploughed across the direction in which the land is ploughed when laid up in stetches for sowing). The cost for labour in burning about 50 chaldron loads per acre is 10*s*. With this dressing of burnt earth, it is asserted that better turnips are grown than with the usual dressing of mixed manure, and that they are always certain of a good crop of barley after burning: the soil is a strong loam.

The following information respecting clod-burning was obtained from Mr. Cluttern, of Tannington, a farmer in the neighbourhood of Framlingham. He states that clod-burning has been practised from 15 to 16 years; the present price of raking clods and for burning is from 7*s*. to 8*s*. per acre, and a man will burn nearly half an acre in a day; 2*s*. per acre is paid for spreading the ashes. The quantity burnt per acre about 35 three quarter loads (27 bushels): and he considers that this dressing of burnt earth is *equal* in effect to *any coat* of muck.

It takes 1 waggon load of "haulm" (stubble) to burn 1½ acre; 1 load of furze will burn 2¼ acres, and 1 load of bean-stalks 2 acres.

In burning it is necessary to clear away the loose soil from the bottom of the heap before the fire is lighted, and of course to light on the windward side. The fires are made about a rod apart, and from 5 to 6 bushels is burnt in each heap. The quantity done of this description of burning depends upon the weather, though many farmers burn their fallows every 4 years. The following crops were obtained from a single coat of burnt earth, which shows its effect on this kind of soil:—

1st year. Fallow, clods burnt for turnips, but too late for roots.

2nd year. Barley, 7 quarters per acre.

3rd year. Peas.

4th year. Wheat, 6 quarters 1 pk. per acre.

5th year. Barley.

Burnt earth is considered by many farmers as the best preparation for turnips; and it certainly makes the adhesive soil work

better, and perhaps reduces some of the insoluble parts of the soil. Many farmers imagine that burning wastes the soil; but it only reduces the organic portion, which is again supplied by the application of farmyard manure. If by burning we are enabled to produce a good root crop on a stiff retentive soil, there is no fear but that the organic matter that has been consumed will be returned to the soil by the turnip crop, and the manure which arises from its consumption.

A great objection to the system is the quantity of stubble and other fuel consumed which might be converted into manure; and there is one injury likely to result from the practice, viz., that it may lead farmers into a bad system of cropping—however there is no reason why this should be the case. The instance which I have already given is not the only one; for some, I believe, have begun the practice of burning the barley and wheat stubbles, and then planting *wheat*. There are of course no covenants in such cases as these.

Paring and burning grass land has already been mentioned.

Clay dug from pits, and the surface soil of arable fields, is occasionally burnt in large heaps, in a manner resembling the practice of burning borders. Though burnt earth is of so much benefit in heavy land, yet on light land unburnt clay has been proved to produce better effects than when burnt.

7. *The improvements still required in the County generally: as to the higher cultivation of existing farms, the reclamation of waste lands, and the condition of the Agricultural Labourer.*

In Suffolk, as well as in many other parts of the country, farmers are frequently bound by covenants for the cultivation of their land under a certain rotation, without sufficiently considering that one rotation or system is not suited to every description of soil; or that more than one kind of soil occurs on the same farm. That it is an error to imagine the 4-course or any other rotation is the best that can be adopted, we may mention the opinion of Mr. Pusey, who says, "The merits of the 4-course system are great; but a great defect too is its monotonous circle of wheat, turnips, barley, and clover." Hence, whatever crops are introduced so as to remove to a greater distance the repetition of this monotonous circle, without breaking the arrangement of growing a corn and green crop alternately, is found to be an improvement. The farmer is often obliged to adopt the same course of cropping on a stiff clay as on a friable sand, although there are many unavoidable circumstances which render it impracticable always to farm in the manner laid down, with the same profit that might be obtained should some of these stringent conditions be taken off the farmer's shoulders. For instance, by being bound to

plough his fallows a certain number of times—in Suffolk, frequently 5 or 6—the farmer, if a little behind-hand, which will frequently occur, either from an excess of dry or of wet weather, will perhaps lose the opportunity of sowing his root crops, merely because he has not yet given the regular allowance of ploughings which he is *bound* to give, and which the land is obliged to receive, without considering whether he is doing good to the land or to himself by such proceedings.

The farmer has often been told, and doubtless with some reason, that he follows in the footsteps of his father and grandfather without stepping out of the way to make improvements in the cultivation of the soil; but as the manner of cultivating that soil by a fixed system, is often chalked out by a lawyer who is not competent to judge of its suitableness to the land, and from which the farmer is not allowed to deviate, how can it be expected that he should do otherwise than tread in the footsteps of those who have preceded him?

The amount of game is also a great drawback to improvement on much of the light land; but any remarks concerning game are uncalled for in this report, and would not in any degree promote the interests of those who occupy farms where game is preserved; for these are entered upon with an understanding that the game is to be preserved, and consequently the tenant pays a proportionably lower rent: in other words, "Game-farms are, or ought to be, let at game-rents."

The greater part of the farm-buildings of Suffolk, improved as they may have been since the time of Arthur Young, are yet far behind the cultivation of the soil, particularly those on the heavy land. In every village are to be seen buildings arranged in every form except that which would give economy in the manufacture of manure, or in the feeding of cattle. Large and expensive barns there are—necessary, perhaps, for flail-threshing and seed-farming, but good and convenient accommodation for cattle is nearly disregarded. In a word, many of the Suffolk farmeries consist only of barns for storing and threshing grain, of a stable and yard for cart-horses, and a shed for the shelter of machines; the shelter afforded to cattle is frequently inferior to that for carts and waggons; a horsepond, the colour of the water contained in it giving evident indications of the presence of liquid manure, is the indispensable adjunct to the buildings; and it may be said, that one of the greatest improvements required is in the erection of farm-buildings with greater *accommodation* for the housing cattle and the manufacture of manure, the threshing of grain, and the preparation of food for cattle. The expenditure for the repair of buildings of this description, built with a view to economy (where stone or brick cannot be obtained,

there is no better material than clay for this purpose), would not be greater than, if equal to, that yearly spent about the present inconvenient structures. The landlord would be deriving *interest* on the money spent in the erection of good buildings, and the tenant would reap much *more* from the economical manufacture of manure, and comfort to his cattle afforded by better farm-buildings. For, in fattening cattle, scientific men have of late years taught us that warmth is *equivalent* to food; and I leave it to any practical farmer to say whether it is cheaper to supply this warmth by walls and roofs or by food.

Suffolk, so noted for machines, is yet backward in introducing the acknowledged improvements of threshing-machinery, and in substituting lighter carts for the clumsy tumbrils. Light one-horse carts would be of great advantage on the heavy soils, as they would not injure the land to nearly the same extent as the heavy loads now carried. The substitution of one-horse carts for waggons and tumbrils is not likely to be carried to any very great extent by the present race of farmers; for though many of them prefer carts, yet the disposal of the old carriages would be attended with a very great sacrifice, and the change of a smart road-waggon drawn by a team of Suffolk horses for a one-horse cart would not meet with approval.

The very light and blowing sands that are under cultivation, might be prevented from blowing by greater shelter, and be rendered more adhesive by the admixture of clay and marl where these can be obtained, and more productive by a higher system of feeding sheep.

Belts of trees, chiefly larch and Scotch fir, and hedges of the latter, afford shelter in some parts; but they require to be greatly extended before they entirely prevent the sand from blowing—high winds being as productive of injury to the crops as continued dry weather. Furze or gorse flourishes well on these barren soils, but is seldom applied to any other purpose than that of affording cover for game, a material for draining, and for firing. The kind of gorse used as provender is a variety closely allied to the gorse which grows so luxuriantly on our heaths; and therefore we may conclude that the former would grow with equal vigour, and afford to the farmers of this sterile tract a plentiful supply of food (of which there is much need) for their cattle and sheep. Those who doubt the feasibility of this improvement will be convinced by referring to the 'Essay on Gorse,' by O. Roberts, vol. vi., p. 379, of the Society's Journal.

The heavy-land district is capable of improvement by the general adoption of the system of autumn cultivation for the root-crop, and by growing such roots as can be removed at an early period from the land, and so doing away with the treading

of wet land during winter, the more free application of manures to green crops on both light and heavy land, and a better management of pasture-land. On this head Mr. Rodwell writes: "On the subject of grass-lands an essay might be well written, not only in pointing out the management of the greater proportion of every variety, but in suggesting improvements by following the examples of other grass counties. On this subject, however, I will not enlarge, and only repeat that which I have long practised, and diffused to all where the position of parties and condition of soils admit it: viz., that as a *general* rule, *pasture* and *meadow* grounds are not only *less productive* in every way to the landlord and tenant, but that the diminution of labour and the very obvious loss of production to the community, are subjects well deserving the consideration of every writer on agriculture, and feel assured that you will not lose sight of so important a feature as the "converting pasture-land into arable."

I fear I shall be unable to do more than echo these suggestions; for Mr. Bravender, in the 'Journal' (vol. vii. p. 161) has so well estimated the gain to the landowner, the tenant, the labourer, and the community at large on various descriptions of land, that I will refer those who have any doubt of the benefit to be derived from breaking up much of the pasture-land of Suffolk, to the calculations that gentleman has made in the latter part of his essay.

Reclamation of Waste Lands.—Much is still required in the reclamation and enclosing of waste lands, particularly the commons, some of which are even yet to be found in the heavy-land district, and are doubtless of a productive quality. There is still a considerable breadth of heath-land in the neighbourhood of Orford and Woodbridge, and on the western side of the county; much of it has so sterile an appearance that unless more than the average amount of capital and skill were employed in its reclamation it would be a profitless task. However, if long leases were granted, or compensation allowed to the tenant for improvements, there is no doubt that farmers of sufficient capital and skill would be forthcoming to render these barren tracts into a good state of cultivation. One would imagine that these barren soils and black heaths would be more profitable if planted with trees, sorts suited to the soil being selected: it would at least be a means of increasing the future productiveness of the soil, if it was ever brought into cultivation. But it is the old enclosed part of Suffolk in which there is the greatest room for the reclamation of waste land; like other early enclosed counties, a great part of Suffolk is disfigured in all directions with hedges and ditches: many of these might be removed without injury to the drainage.

The removal of the hedges that are not required, and the pollard-trees with which so many of them are so thickly studded, would reclaim more waste land than the bringing the tracts of heath into cultivation; for these are worse than waste: they require an annual expenditure to keep them in repair; their roots, by exhausting the land, injure the crops to a great distance into the fields; their shade delays the ripening and harvesting of the crops, and harbours an infinite quantity of vermin in the shape of birds and insects. Land is seldom at so dead a level that it cannot be drained on the Suffolk system (of shallow drains) if the fields do not exceed eight acres in extent (there are many of not half this area); and where there is a good fall, from 12 to 15 acres would be a more profitable size for heavy land fields.

As a common example, I observed that the Brandeston Hall estate, sold by auction by G. Robins in 1841, containing an average of about 650 acres of land, was subdivided into nearly 160 enclosures.

The condition of the agricultural labourer has undoubtedly improved; but much remains to be done by the landowners and farmers of the present day. Since the introduction of the New Poor-Law the Suffolk labourer has become more independent, and he has not that disinclination to work for his living which some of the worst-disposed of them formerly had under the old system. Though the wages at day-labour, 10*s.* per week, may appear a small sum for the support of a labourer and his family, yet this is far from being the sum total of his earnings; during the five weeks of harvest the Suffolk labourer is in receipt of upwards of 1*l.* a-week; and at other times frequently earns at piece-work from 12*s.* to 13*s.* per week. It would, perhaps, be as well if the standard of wages was more generally fixed, which can only be fairly taken by adjusting the price of labour to the price of grain. The following system of paying labourers is adopted by Mr. Cooper, of Blythburgh Lodge, who farms upwards of 2000 acres, and by other East Suffolk farmers.

He takes the average price of wheat as his standard, both as being the most valuable production of the labourer's toil, and the principal article of his food :—

When wheat is above	5*s.*	per bush. and under	6*s.*	he pays	8*s.*	per wk.
"	6*s.*	"	7*s.*	"	9*s.*	"
"	7*s.*	"	8*s.*	"	10*s.*	"

Thus increasing 1*s.* per week for every 1*s.* per bushel increase in the price of wheat.

Mr. C. also allows the labourers flour at the wholesale price. He makes a bargain with the miller to supply his labourers; in this manner the labourer gets the profit of the flour-dealer. At first, Mr. C. thought of buying flour in large quantities, and

letting his labourers have it at cost price; but, as this would interfere with the miller's trade, he now pays the miller himself, or engages to see him paid, and gets the money from his labourers in weekly instalments: they may take as little as 2 stone, or as much as half-a-sack; thus, when flour is cheap, they can lay in a stock. Mr. C. gets a list of the quantity required by each man, and the miller sends his cart round once a-week. It is, of course, quite optional for the labourer to take his flour in this way or not.

Taking the labourers generally, it would be to their advantage if some means were adopted for a more general and efficient education than they now receive at the village school.

Many landowners object to investing money in cottages, thinking by so doing they will burden their estates with poor. But this only drives the labourer into the hands of the speculator, who builds cottages and lets them at an exorbitant rent.

The Rev. Copinger Hill, in his 'Essay on Cottages' (in the 'Journal'), has proved that the erection by the landlord of comfortable cottages, with a garden attached, let at a reasonable rent, will pay good interest for the money invested. Cottages built of clay, the warmest and driest material that can be used, may be let at 3*l.* per annum; and where this is done, the speculator, who crowds a lot of cottages on a small plot of ground, and lets them from 5*l.* to 6*l.* each, will be driven from the field. All agree that the condition of the labourers is improved by annexing a large garden to the cottage; this does away with the necessity of field-allotments, the usefulness of which has many advocates, though some are of quite a different opinion respecting them. "Spinning" yarn by hand is now nearly superseded by the introduction of machinery.

To conclude, I must apologise for having entered so minutely into the details of management: my reason for doing so is to render the report intelligible to farmers in a distant part of the country, for there are many local phrases used in our farming operations which would be perfectly unintelligible to the farmers of another county.

I am deeply indebted to many of the Suffolk farmers for their kind and ready assistance in affording me information on the various subjects of this Report, and to these gentlemen I beg to tender my sincere thanks; and I hope the use that I have made of the information which they have afforded will not be deemed altogether unworthy. If the Report possesses any merit, it belongs mainly to them: if it is considered unworthy of the county, the agriculture of which it has been my endeavour to describe, the disgrace rests upon myself; but should I be unfortunate in obtaining the good opinion of the agricultural reader, the Report

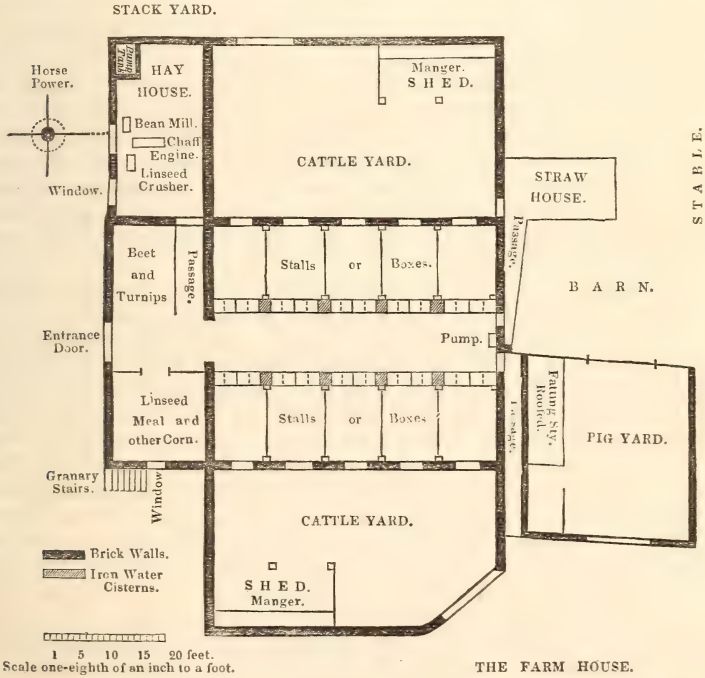
may perhaps be viewed less critically when it is known that it was written with a view of acquiring rather than of imparting knowledge.

APPENDIX.

1. *Linseed Compound.*

MANY Suffolk farmers during the last few years having substituted compound in lieu of linseed-cake, a few observations on the system of compound-feeding, derived from practical experience, may not be considered out of place.

Mr. Peirson, of Framlingham, a gentleman who adopts the system, has kindly favoured me with a plan (which is here annexed) of his feeding-shed, and an account of his manner of feeding.



"I am pleased my bullock-shed attracted your attention, believing there is scarcely another in Suffolk combining the same advantages for grazing, with economy in building. The elevation is 8 feet 2 inches from level of ground to under-side of beams, which some persons have thought 1 foot too much. The roof of one span, and covered with pan-tiles; the stalls are all sunk from $1\frac{1}{2}$ to 2 feet below the level; the pump

is supplied by the troughs around the building, and seldom fails or water. The width of passage between the stalls allows of carting in turnips, &c. The stalls are adapted for tying up two beasts in each, two polled or one-horned bullocks may be loose. I generally have two in each stall during the winter, and one during the summer months. When two are tied up, the manure taken from them is thrown into the outer cattle-yards, and again foddered upon by leaner cattle. When loose in the stalls, nothing is removed till quite full; there is a drainage from the stalls and piggeries to the tank; the tank is a large bricked arch running under the hay-house about 6 feet in depth. Each stall having separate doors, I am enabled to regulate the heat of my shed, opening the upper doors on the contrary side to the wind; and, during the heat of the last summer, I closed them all. The shed being dark, the bullocks were not troubled by flies, and the ventilation in the roof kept them cool. Three strong ash rails divide the stalls, fastened with pegs into the posts, that they may be removed in an instant if required. The doors are also guarded by two ash rails (removable).

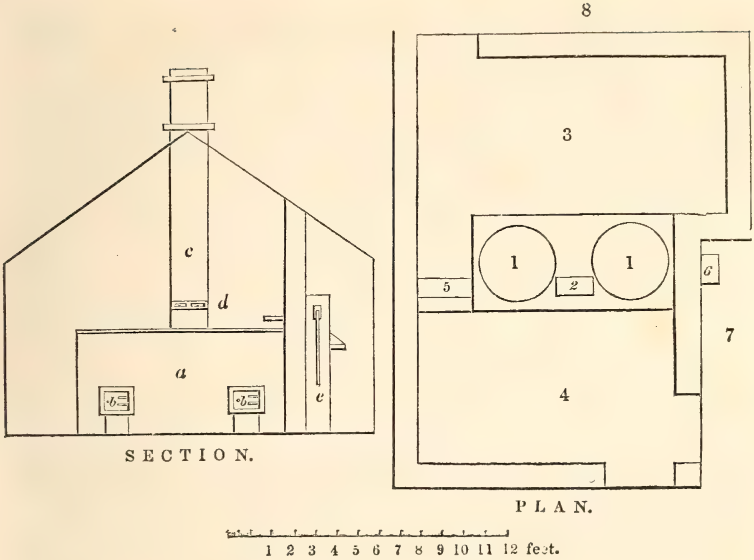
"My plan of making the compound is to put 9 pails of water into a copper; when boiling-hot, scatter in 2 pecks of crushed linseed, boil this five minutes, then stir in 4 pecks of bean or pea meal; as soon as this is done, take away the fire that it may not burn. With a wooden shovel empty the contents of the copper into two small tubs, where it may remain till next morning, when, being turned over, they will show you two puddings of about 10 stone each (14 lbs. per stone). This is ready to slice and give to the cattle. As the bullocks progress, I increase the linseed. For the last two years I have cooked 20 stone daily, with few exceptions.

"The cost of my pudding, including fire and labour, I estimate at 4½*d.* per stone; and this I believe equal to two English cakes at 6*d.*

"I engage my man to be in the shed at 5 o'clock every morning, and to give 1 stone of pudding to each beast as the first food. From 1 to 2 bushels of roots are given during the day, and 3 or 4 half-peck baskets of hay or other chaff, generally mixing with it 1 to 2 pints of crushed linseed, and 4 pints of bean-meal. Every evening at 8 o'clock, from 2 to 4 lbs. of uncut hay are given to each, if the stack-yard will allow of it. When the bullocks are getting fat, I increase the pudding to 2 stone per head, and reduce the roots to 1 bushel each. The beasts are supplied with water. By preparing common white turnips, swedes, mangel wurzel, tares, clover, and grass, I have a succession of green food the whole year. The food is prepared and placed in baskets near each beast before any is given, so that all may be eating at the same time, and, owing to this regularity of feeding, all the bullocks are generally laid within 5 minutes after eating their allotted quantity."—*Dec.* 24*th*, 1846.

In addition to these excellent observations, I beg to give a plan of a boiling-house, two or three of which have lately been fitted up for the preparation of compound on a considerable scale.

The boiling-house, of which the annexed drawing is a plan, occupies the angle formed by the bullock-shed and piggery.



Reference to Plan.

1, 1. Iron boilers holding 100 gallons each. Two boilers are greatly to be preferred to one, as a man can tend two fires at the same time. The top of the brickwork is covered with one-inch boards, the boiler-lids are made in two pieces for the convenience of taking off, and they fit close into the covering of boards.

2. Flue.

3. The brick floor of this compartment is raised about 9 inches, and the part (4) in front of the furnace is lowered about 9 inches. The floor at the back of the boiler being raised gives great convenience for stirring and mixing the compound, and in removing it from the boilers. The common situation of a copper at the side or in the corner of a building will not admit of this arrangement, for the man employed in stirring would be obliged to be elevated on a stool immediately in front of the furnace, which is not a very agreeable position, or one in which the man is likely to perform his work as it ought to be done. Some portion of this place may be fitted with tubs or cisterns for the reception of the compound.

4. Place in front of furnace for tending the fire and keeping a supply of fuel.

5. Steps.

6. Pump. The water is pumped directly into either copper; it also supplies water to the cattle and pigs.

7. Piggery.

8. Bullock-shed.

Section.

a. Boilers. *b, b,* Furnaces. *c,* Flue.

d, Dampers for regulating the fire and putting it out when required. The dampers are of great service, as without them there is some danger of the mixture boiling over when the linseed is added to the water; they also effect a saving in the fuel.

e, Pump.

The building is lighted by glass tiles in the roof, and the steam passes out by a lever boarded window, and through interstices formed by lapping the ridge-tiles over one another.

The grain and linseed require to be crushed, and the straw or hay to be cut into chaff before it is prepared. Hurwood's, of Ipswich, is

one of the best mills for crushing linseed, oats, &c.; but whatever kind are used, they should admit of being driven by horse-power or by steam.

The mills are placed over the chaff-machine, and can be worked at the same time, and driven by the same power, as the chaff-cutter.

The following is the actual time of crushing, the mills being each driven by one horse, the increase of bulk by crushing, and the cost.

Parsons' and Clyburn's V. mill crushes 1 qr. of peas or beans in 40 minutes.

			h.	m.
Hurwood's mill,	1 quarter of	linseed in	1	20
	1 ,,	barley . .	1	0
	1 ,,	oats . .	1	0

	Whole. lbs.	Crushed. lbs.
1 bushel of linseed weighs	51	32
1 ,, barley ,,	54	36
1 ,, peas ,,	67	49
1 ,, oilcake ,,	—	45

The cost for the labour of attendance, horse, and wear and tear of the machinery is about 8*d.* per qr. for oats and barley, 10*d.* for linseed, and about 6*d.* for peas.

Though grain cannot be ground to powder by these mills, yet their use is a very great saving on the practice of sending grain to be ground by the miller, whose charge is about 2*s.* 6*d.* per qr. Oats may be ground as well by a steel mill, and linseed much better than it can be done by stones.

It would be an endless task to attempt to describe all the different ways of preparing compound adopted by different farmers. Linseed being the foundation upon which the compound is based, the other substances employed are barley, peas, beans, gold of pleasure, and a cheaper compound of boiled linseed and cut hay, straw, &c. As a general maxim, the constituent which forms the largest proportion in the linseed compound is that which bears comparatively the lowest price in the market; thus, in 1845, when barley was at a low price, a great quantity was made into compound: it also affords a ready means of converting dross and inferior grain into a nutritious food.

Estimate and manner of preparing a Compound of Peas, Linseed, and Barley.

A 100-gallon boiler of compound is prepared in the following manner:—

	Stone	lbs.
2 bushels of crushed peas weighing	7	0
2 ,, linseed ,,	4	8
6 ,, barley ,,	15	6
	27 stone of 14 lbs.	
64 gallons of water weighing .	45	
Total . .	72	

Sixty-four gallons of water being pumped into the boiler, 2 bushels

of crushed peas are put in, and the fire lighted. The peas will require boiling from 2 to 3 hours, till the mixture nearly resembles pea-soup, and the peas feel soft and mealy; one person now sprinkles 2 bushels of crushed linseed gradually by hand into the boiler, while another stirs up the mixture. The stirrer, or "rudder," is similar to those used by brewers; the stirring part may either be made of wood or iron. When the linseed is dissolved, the 6 bushels of crushed barley are gradually stirred into the boiler, until the whole is well mixed and incorporated together. The fire should now be put out by closing the damper; this will be of great use throughout the entire operation in regulating the fire. The copper-lids are put on: if the compound remains in the boiler it will be cool enough for the cattle the following day. The ingredients thus made will fill a 100-gallon copper, and will weigh about 68 stone, showing a loss of 4 stone by boiling.

From 1 to 2 stone of this compound is given with chaff to each bullock per day, at 3 baits. For sheep, a quantity is removed from the boiling-house to the field or shed in which the sheep are fattening, and it is given night and morning at the rate of about 2 lbs. per sheep per day; but this of course varies with the size and condition of the sheep.

Average estimate of cost of 68 stone of compound:—

	£.	s.	d.
7 st. peas	0	7	0
15 st. 6 lbs. barley	0	15	0
4 st. 8 lbs. linseed	0	6	6
Attendance and fuel	0	1	6
	£1	10	0

This will be rather over $5\frac{1}{4}$*d.* per stone, or 3*l.* 10*s.* 7*d.* per ton.

2. *Clay Walling.*

Throughout the heavy land of Suffolk cottages and farm-buildings are principally, and farm-houses very often, constructed with clay walls. Clay houses whitewashed, plastered, or stuccoed, are not only neat in appearance, but are warm and durable.

Clay walls appear peculiarly adapted for the walls of sheds and for enclosing farm-yards; they are cheap, warm, never give out damp, and, if kept dry at top and bottom, will last for a great length of time. I have seen some that have stood 50 years with very slight repair, which were in every respect as good as when first put up. Cattle are not liable to injury by rubbing against them, as they are with rough stone walls. Clay walls are placed on a stone or brick pinning of from 2 to $2\frac{1}{2}$ feet high, or about as high as the manure rises in the yards; when completed, the walls are covered to prevent their being washed down by the rain, the material used being a brick coping, slate, boards, thatch, &c. The cost of building a wall 14 inches thick is 9*d.* per square yard, the stone pinning 6*d.* per foot run extra, the thatching about 1*s.* 6*d.* per yard run. This does not include the straw, or the cost of raising clay. The whole expenditure for a 14-inch wall is about 1*s.* a square yard. For further information as to the preparation of the clay, &c., see the Rev. C. Hill's 'Essay on Cottages,' Journal, vol. iv., p. 356.

Hengrave, Bury St. Edmunds.

XIII.—*Report on the Exhibition of Implements at the Northampton Meeting*, 1847.

Mr. Parkes has been for some years in the habit of drawing up the Report of the annual exhibition, and the Stewards have, in his unavoidable absence through illness, to crave the indulgence of the Society for not being enabled to bring to the subject either the ability or the knowledge which the consulting engineer has invariably displayed in the construction of his reports. They have determined therefore to rely upon the reports of the Judges themselves as their groundwork, and merely to make such additions to, or alterations in, the description of the implements subjected to trial as the very faulty certificates originally sent in, and printed in the catalogues, imperatively demand. The absence of Mr. Parkes, however, from the Northampton Meeting is the more to be lamented, as not only was the number of implements exhibited greater than at any previous show, but mechanical improvements had evidently much advanced since the last meeting at Newcastle. By a reference to the entries which have been made annually in the Implement Department since the formation of the Society, it will be found that at—

Oxford*	they were . . .	23
Cambridge	" . . .	36
Liverpool	" . . .	312
Bristol	" . . .	455
Derby	" . . .	508
Southampton	" . . .	948
Shrewsbury	" . . .	942
Newcastle	" . . .	735
Whilst at Northampton they amounted to	.	1321

A vast increase! for which the Society is mainly indebted to the liberality of the railroad companies, who transport to and from the place of exhibition the animals and implements shown at its annual meetings. The Council, in the absence of the consulting engineer, gave full liberty to the Stewards to call in an engineer in any cases of difficulty that might arise; but this privilege was not exercised.

The extraordinary feature of the show was the number of portable steam-engines produced: heretofore there have never been above two exhibited at any meeting; but the Council having acted

* The respective entries as given at Oxford and Cambridge do not in any degree indicate the number of implements exhibited; as the exhibitor at these periods merely sent in a general certificate, and then forwarded what implements he pleased, it being understood that the more he sent the better. There were, however, at the two first meetings of the Society but 23 and 36 exhibitors making entries, whilst at Northampton there were 142.

wisely in determining to ensure as much as lay in their power the manufacture of machinery adapted to reduce the cost of production, by increasing their premium given to this class of implements to 50*l.*; no fewer than seven portable engines, together with one stationary, were entered for competition: and when we take into consideration the number of useful engines produced, we cannot but congratulate the Council upon the success which has attended this their first attempt to give a stimulus to the exertions of machinists, by holding out for competition a premium worthy of their acceptance. Unfortunately the way in which the premium was worded led to grievous disappointment as regarded one exhibitor, Mr. R. Broadbent, who produced a stationary engine before them, and which, it being impossible to test, had no chance whatever in the competition, the Stewards recommend that henceforward the wording of the premium should be altered so as to exclude entirely stationary engines, the working of which at an annual show it will be impossible for the Judges to inspect; should they not all be of a piece, which many are, to which class competition should be restricted.

Connected with this subject, and well worthy of attention, is the adoption hereafter of forms, to be filled up by the machinists, relative to the power at which their respective implements are formed to work. A proposition of this description was brought before the Council too late for adoption, or indeed even for consideration, this year. The Stewards were anxious, however, to prove how far the system was feasible, and therefore gave instructions to the Judges to carry out as far as possible the plan proposed by Colonel Challoner, drawing out a tabular form for the Judges of steam-engines and thrashing-machines, and begging the others to keep in mind, during their inspection and trial of the respective implements, the plan proposed for their consideration.

In the resolution formally submitted to the Council, the following was the information required to be given to the Judges previously to the trial of their respective implements:—

That instructions be given to the Judges of the Northampton Meeting to ascertain from the makers of the machines, previous to trying or examining them (if hand-machines), the number of turns of the handle they have calculated that it ought to make, and the power in lbs. weight they require to be applied; and that, in trying the quantity of work the machine will do, no greater speed be allowed to be given to it.

That no horse-machine be allowed to compete that is calculated for a greater speed than 30 turns per minute, and a greater power than 24 lbs.

In machinery driven by horse-power the Judges to obtain from the

maker the speed he has calculated the machine to be driven at, and the power he has estimated the horses to give, and that care be taken that no greater speed be allowed under trial.

That no horse-machine be allowed to compete that is calculated to travel more than $2\frac{1}{2}$ miles per hour, or 220 feet per minute, at a power not exceeding 168 lbs.

In machinery driven by steam, the exhibitor to give the Judges the pressure of the steam in lbs. per circular inch, the size of the safety-valve, the length of the lever, the proportions of the lever, and the weight upon the lever, the number of strokes the engine is to make, and the number of feet it travels per minute; and that on no account shall a higher pressure be used during the trial. The Judges to adjust the safety-valve before trial, and allow no greater speed to be used than the speed it is calculated for.

That no engine be allowed to compete with steam above 50 lbs. per square inch, or 40 lbs. per circular inch.

The Stewards, in the endeavour to follow out this plan as nearly as possible, called the Judges together previously to the inspection of the implements, and read to them the following instructions, upon which they begged them as far as possible to report:—

Hand Machines.—1. The number of turns of the handle calculated that it ought to make.

2. The power in lbs. weight required to be applied.

Instructions.—In trying the quantity of work done, no greate speed be given than that specified.

Horse-power.—1. The speed at which it is calculated to be driven.

2. The power that the horse has been estimated to give.

Instructions.—No greater speed to be allowed on trial than that specified.

Steam Engines.—1. The quantity of fuel necessary to get up the steam.

2. The quantity necessary per hour to keep it at work.

3. The number of horse-power.

4. The pressure of the steam in lbs. per square inch.

5. The size of the safety-valve.

6. The length of the lever, the proportions of the lever, and the weight upon the lever.

7. The number of strokes the piston is to make, and the number of feet it travels in a minute.

How far the Judges were enabled to carry out this plan will be perceived in their subsequent report.

The following were the prizes offered by the Society:—

For the Plough best adapted to heavy land . . . Ten Sovereigns.
For the Plough best adapted to light land . . . Ten Sovereigns.
For the best Drill for general purposes, which shall possess the most approved method of Distributing Compost or other manures in a moist or dry state, quantity being especially considered . . . . . Fifteen Sovereigns.

[Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.]

For the best Turnip Drill on the flat which shall possess the most approved method of Distributing Compost or other manures in a moist or dry state, quantity being especially considered . . . . Ten Sovereigns.

[Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.]

For the best Turnip Drill on the ridge which shall possess the most approved method of Distributing Compost or other manures in a moist or dry state, quantity being especially considered . . . . . Ten Sovereigns.

[Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.]

For the best Scarifier . . . . Ten Sovereigns.
For the best Chaff-cutter . . . . Ten Sovereigns.
For the best Machine for making Draining Tiles or Pipes for agricultural purposes. Specimens of the Tiles or Pipes to be shown in the yard: the price at which they have been sold to be taken into consideration, and proof of the working of the Machine to be given to the satisfaction of the Judges . . . . Twenty-five Sovs.
For the best Harrow . . . . Five Sovereigns.
For the best Drill-Presser depositing Manure and Seed . . . . Ten Sovereigns.
For the best Churn . . . . Five Sovereigns.
For the best Weighing Machine for live Cattle and Farm Produce generally . . . . Ten Sovereigns.
For the best and most economical Steaming Apparatus for general purposes . . . . Ten Sovereigns.
For the best Skim or Paring Plough . . . . . Five Sovereigns.
For the best Subsoil Pulverizer . . . . Ten Sovereigns.
For the best Horse Seed-Dibbler . . . . . . Fifteen Sovereigns.
For the best Linseed-Crusher . . . . Five Sovereigns.
For the best One-Horse Cart . . . . Ten Sovereigns.
For the best Thrashing Machine applicable to Horse or Steam-power . . . . Twenty Sovs.
For the best and most economical Set of Tools and Instruments for Draining purposes—
1. For laying Pipes in Clay . . . . . . Five Sovereigns.

2. For laying Pipes in Friable Land . .	Five Sovereigns.
3. For General Draining	Five Sovereigns.
For the best Portable or Fixed Steam Engine, applicable to Thrashing, and other Agricultural purposes	Fifty Sovereigns.
For the most approved Model of a Permanent Rick-yard, regard being had to economy, durability, and protection from vermin. *Given by the President*	Twenty-five Sovs.
For the best Drain-Plough to cut out at one, two, or three cuts, to the greatest depth, with not more than four horses, so as to prepare a drain so far for deeper cutting (*including* 10*l. added by Mr. Slaney*)	Twenty-five Sovs.
For the best Plough to fill in the soil cast out of drains, with not more than 4 horses (two and two abreast), and not to exceed 5*l.* in cost. *Given by Mr. Slaney*	Ten Sovereigns.
For the best Corn-dressing Machine	Fifteen Sovs.
For the set of Harness best adapted for Agricultural purposes	Five Sovereigns.
For the best Gorse-Bruiser	Ten Sovereigns.
For the best Implement for distributing pulverized Manures broad-cast	Ten Sovereigns.
For the best Grinding-mill for breaking Agricultural Produce into fine meal	Fifteen Sovs.
Miscellaneous Awards	Ten Sovereigns.

For the invention of any new Implement, such sum as the Council may think proper to award.

The Judges selected by the Council were—

John Morton, Whitfield, Thornbury.	T. P. Outhwaite, Bainesse, Catterick.
Peter Love, Naseby, Welford.	Isaac Everett, Caple, Ipswich.
Weston Tuxford, Boston.	William Hesseltine, Worlaby, Barton.
Henry Taylor, Dilham, Norfolk.	Thos. Crisp, Gedgrave, Woodbridge.

But on the Stewards arriving at Northampton on the Thursday preceding the show, Mr. Tuxford, of Boston, was objected to as being himself an implement-maker, and having a machine in the yard for exhibition made by himself, but exhibited by another implement-maker. The Stewards, having taken the objection into consideration, determined not to employ Mr. Tuxford as a Judge, and selected Mr. Shaw, of Far Cotton, near Northampton, to act in his place. The division of work assigned to the Judges was as follows:—

To Messrs. Morton and Love . .	Steam-engines and Barn-machinery of every kind.
To Messrs. Outhwaite and Hesseltine .	Ploughs and general field-implements.
To Messrs. Everett and Taylor .	Dressing-machines, Tile-machines, Drills, Carts, Steaming-machines, and Dibblers.
To Messrs. Crisp and Shaw . . .	Miscellaneous.

The following were the awards:—

Kind of Implement.	Prize.	No. of Stand.	No. of Article.	Name of Exhibitor.
	£.			
For the best Plough for heavy land . .	10	56	3	Mr. Busby.
For the best Plough for light land . .	10	48	2	Mr. Howard.
For the best Drill for general purposes .	15	99	2	Messrs. Garrett.
For the best Turnip Drill on the flat . .	10	99	5	Messrs. Garrett.
For the best Turnip Drill on the ridge .	10	99	6	Messrs. Garrett.
For the best Scarifier	10	104	17	Messrs. Sharman & Co.
For the best Chaff-cutter	10	58	5	Mr. Cornes.
For the best Pipe and Tile Machine . .	25	82	26	Sanders, Williams, & Taylor.
For the best Harrows	5	82	1	Sanders, Williams, & Taylor.
For the best Drill-Presser	10	46	10	Mr. Hornsby.
For the best Churn	5	33	4	Mr. R. Robinson.
For the best Weighing Machine . . .	10	115	3	Mr. James.
For the best Steaming Apparatus . . .	10	33	1	Mr. Robinson.
For the best Skim or Paring Plough . .	5	71	5	Mr. G. Kilby.
For the best Subsoil Pulverizer . . .	10	60	1	John Read.
For the best Horse Seed-Dibbler . . .	15	1	1	Mr. Newberry.
For the best Linseed-Crusher	5	114	12	Mr. Ferrabee.
For the best One-Horse Cart	10	105	22	Mr. Stratton.
For the best Thrashing-Machine . . .	20	99	15	Messrs. Garrett.
For the best Draining Tools for clay land	5	59	4	Mr. Clayton.
For the best Draining Tools for friable land	5	75	76	Messrs. Mapplebeck & Lowe.
For the best Draining Tools for general draining	5	75	78	Messrs. Mapplebeck & Lowe.
For the best Steam-Engine	50	40	1	Mr. Cambridge.
For the best Model of Rick-Yard . . .	25	..	..	Withheld.
For the best Drain-Plough	25	..	..	Withheld.
For the best Plough to fill in drains . .	10	..	..	Withheld.
For the best Corn-dressing Machine . .	15	23	1	Mr. Cooch.
For the best Set of Harness	5	..	..	Withheld.
For the best Gorse-Bruiser	10	..	..	Withheld.
For the best Broad-cast Manure Distributor	10	43	53	Mr. Croskill.
For the best Grinding-Mill	15	..	..	Withheld.

MISCELLANEOUS.

Kind of Implement.	Award.	No. of Stand.	No. of Article.	Name of Exhibitor.
For the best Clover-Seed and Rye-Grass Barrow	Silver Medal.	52	10	Mr. Smyth.
For the best Fire-Engine	,,	60	4	Mr. Read.
For the best Horse Drag Rake . . .	,,	102	1	Mr. Grant.
For the best Gardener's Turnip-cutter .	,,	75	59	Messrs. Mapplebeck & Lowe.
For the best Oil-Cake Breaker . . .	,,	108	19	Messrs. Wedlake & Thompson.
For the second-best ditto	,,	77	4	Mr. Nicholson.
For the best Horse-Hoe	,,	99	12	Messrs. Garrett.

On the different classes referred to their respective opinions the Judges have submitted the following observations:—

PORTABLE STEAM-ENGINES.

Tabular Statement given by Exhibitors.								Statement by the Judges.		
Stand.	No.	Maker's Name.	Consumption of coal per diem.	Horse-power.	Pressure per inch.	Revolutions per minute.	Price.	Time of working.	Number of Sheaves Thrashed.	Observations. For description of Engines, see the Catalogue.
			cwts.		lbs.		£.	Minutes.		
19	1	D. Ogg, Northampton . .	5	5	50	80	200	8	94	This engine worked with a chaff-cutter too, but this had to be detached, as it reduced the speed of the thrashing-machine.
35	1	Barrett & Ashton, Hull . .	6	5	45	90	189	8	84	See the Catalogue.
41	1	W. Cambridge, Market Lavington, Devizes.	5	4	72	110	140	10	209	This engine is of a very simple construction, worked by a pressure of from 60 to 68 lbs. per inch, and the revolutions about 160 per minute.
46	8	Hornsby	7	6	40	100	245	7	140	Very complete engine, regulated in its velocity by a governor, and worked at about 40 lbs. pressure; revolutions about 100 per minute.
55	1	Bloxon	6	5	65	120	160	8	83	See Catalogue.
80	2	Ryland and Dean . . .	5	6	50	90	300	10	193	Do.
104	155	Johnson	11	6	50	80	245	5	80	Do.

The Judges observe that, without the proper means of measuring the power of the steam-engines which were tried, they could only exercise their own judgment in estimating their merits; and, taking at the same time simplicity of construction, excellence of workmanship, and neatness of the whole, they consider Engine No. 1, Stand 41, made by Cambridge of Market Lavington, Devizes, to be the most deserving of the premium offered by the Society, and they therefore award the premium of 50*l.* to Mr. Cambridge for his steam-engine.

The steam-engine exhibited by Mr. Cambridge on this occasion materially differed in construction from those he has before shown, for whereas, in the engine which was at Newcastle, the cylinder and valve-box stood inside the boiler, and the crank revolved in the top of the cylinder, presenting the greatest difficulties in getting at the working parts in case of want of oiling or repairs, the one now exhibited had all these objections removed, as the working parts are placed outside the boiler, a greater length is given to the connecting-rod, and the working parts are kept cool. The steam-pipes of this engine are fixed above the boiler, which has the effect of preventing any accumulation of water in the valve-box or cylinder. The fly-wheel is 18 inches in diameter larger, and the extra weight of it 2 cwt., causing the engine to maintain a more regular motion. It is altogether more simple, and is made much stronger in all its parts, being capable of working, if necessary, up to 6-horse power.

The portable steam-engine, applicable to thrashing or other agricultural purposes (4-horse power); improved and manufactured by Mr. Ogg.—The above has a locomotive tubular boiler, with fire-box surrounded with water, and constructed to consume the smallest quantity of fuel; a dome at firebox-end of boiler for steam chamber, and ash-pan containing condensed water from cylinders, for cinders to drop into; safety-valve fixed on top of dome, and the pressure adjusted by the patent spring balance; whistle, for signal, when required; two steam cylinders, supported by brackets upon frame at each side of boiler in a horizontal position, with direct-action, expansive valves, and exhausting into a cistern, through which the cold water from the forcing pump is conveyed in a coil of small pipes before it enters the boiler. By this arrangement the water becomes heated, and thus prevents that condensation of steam, and consequent waste of fuel, which would result from the injection of cold water. The pump worked by the engine, to supply the boiler with water, is so constructed that it may be disconnected from the engine, and used at any time by hand-power, at a longer stroke, to fill the boiler (when empty) with cold water. The tubes from the fire-box communicate with a smoke-box, placed at end of boiler, upon which the chimney is fixed. At the top of the chimney there is an apparatus which is called a spark-catcher, the importance and advantage of which is, that it is perfectly impossible for sparks or small cinders to pass through it, even though the draught through the fire and tubes might occasionally be powerful enough to bring them into the chimney; at the same time the draught necessary for the effectual operation of the engine is not in any degree diminished. The steam-engine and boiler are fixed upon a strong oak carriage, with four wheels

(hind wheels 3 ft. 4 in. diameter, the fore wheels 3 ft. diameter). The weight of the whole, including carriage and wheels, is about $2\frac{1}{2}$ tons; the consumption of fuel per day, at full power, from 4 to 5 cwt. The power of the engine may be used from either side, either right or left, as required; and the connecting or driving shaft attached in a direct line with the thrashing-machine, thus simplifying the machinery, and making the best use of the power. Price 200*l*.

A portable steam-engine, 5-horse power; invented and manufactured by Messrs. Barrett and Ashton. It is nominally of 5-horse power, but capable, from the capacity of the boiler and cylinder, of working up to a much higher power. An agricultural steam-engine being much exposed to the weather, and consequently the frictionable parts liable to corrosion, brass is introduced as far as necessary (being a non-corroding substance); this will be found of great service in preserving the full power of the engine, and also its durability. The cylinder is furnished with a brass metallic piston, insuring its being at all times ready for immediate use; the rod of the piston is cased with brass; and the force-pump, being susceptible of getting out of repair through corrosion, by hot and cold water continually passing through it, is also made of brass entirely, instead of iron. In this steam-engine the principle of direct action is carried out. The piston-rod communicates immediately to a connecting link formed like a bow: to the upper part of it the connecting-rod is suspended, so that when the engine is at work the crank performs its revolutions in this bow. The object of this contrivance is to bring the working parts of the engine under the entire control of the person who attends it, and yet to keep them at a convenient distance from the ground, so as not to endanger them when travelling on bad roads. The engine is capable of giving out from 60 to 300 revolutions per minute; and one uniform speed can be maintained throughout by means of a governor. In thrashing, the variation of the feed to the machine gives the engine a constant irregular motion, which is not only injurious to the engine itself, but also to the working of the machine; but the governor or regulator always preserves the same uniform velocity that is fixed upon: if the machine be fed lightly, or if some other machine (which may be working with the thrashing-machine) is disconnected or stopped, the governor instantly shuts off a proper portion of steam from the cylinder, and the reverse if a greater amount of power is required from the engine. To prevent the bright part of the engine being exposed so much to the weather, the working parts of the entire engine are enclosed in a wooden box, which can be locked up and made secure from the interfer-

ence of any inexperienced person when it is not at work. In the boiler of this steam-engine the makers have, in designing a plan for economizing fuel, not neglected the important point of preventing danger of fire from sparks; but with the length of flue, the means of subduing the draught, with the addition of a smoke-box, this danger to the stack-yard is obviated. The flues are return and turn-over flues, and of sufficient capacity to be readily cleaned out. At the end of the first row of flues is fixed the smoke-box: the use of this is to prevent and receive any sparks arising from the fire (as in the case of railway engines). The boiler has all the advantages of the small tubular boiler, without the danger and complexity, as sufficient steam-generating surface is obtained without the liability of priming. This is of importance, especially in rural districts, where the coal is often bad, and the water strongly impregnated with earthy and saline matter. Every part of the boiler is well strengthened by stays, and before leaving the manufactory is tested at full double its working pressure. In this boiler fuel is saved, by the water being heated before entering the boiler, as the waste steam is injected by the force-pump through a vessel from where the supply of water is taken. To the boiler is also attached a steam-whistle in connection with the water-gauge, so that if the water by any means gets low the action of the gauge is to open the cock of the whistle, and thus give instant notice to the person in attendance. Price 189*l.*

Mr. Hornsby's was a six-horse power portable steam-engine, with locomotive boiler, 36 tubes in the horizontal part, fire-box, and smoke-box complete; the engine simple in construction, with governor to regulate the speed, very easy to manage by a farm-labourer; calculated for driving thrashing-machines, chaff-cutters, or any other machinery used in farm purposes. Price 245*l.*

A five-horse power portable steam-engine, with shafts, wheels, &c., complete; invented by Edward Bloxsom, of Gillmorton, and manufactured by the exhibitor.—This engine is constructed with the greatest regard to economy in its working. The principal novelty is its capability of being worked at any required power, from about one horse to five. The working parts are placed under the boiler instead of on the top or side, which has a two-fold advantage; for the works being nearer the ground, the engine works steadier; and being more enclosed, are not so liable to accident. Another important improvement is its capability of being worked either way. There is no danger to be apprehended from the fire, as the fire-box is enclosed with the cold-water tank, which answers the double purpose of supplying the boiler and cooling the cinders, sparks, &c., and the chimney is fitted with a dome which prevents the sparks from flying out at the top. The working parts are fitted with the greatest regard to

durability, with superior brass pistons, valves, tubes, &c., so that it is not liable to corrode, and is ready for immediate use after standing any length of time. Price 160*l.*

A portable steam-engine, of six-horse power, on wheels, with shafts, &c., complete, for travelling; invented, improved, and manufactured by Messrs. Ryland and Dean. This engine has two working cylinders, fitted with superior metallic pistons, and is so simple as to be easily managed by any intelligent farm-labourer. It is manufactured and constructed with every regard to economy of fuel, durability, and efficacy. Price 300*l.*

A portable steam thrashing-machine; invented by Messrs. Tuxford and Sons, of Boston, Lincolnshire, and manufactured by them for Thomas Johnson, of Leicester. The engine is of six-horse power, simple and strong in its construction, and not liable to get out of order. The boiler is small, and well adapted for generating steam quickly, being amply sufficient for this sized engine. It is furnished with wrought-iron welded tubes upon the locomotive principle. The door at the back of the smoke-box, and to which the force-pump is fixed, is double; thus forming a heating chamber for the water, and security from fire through the door becoming overheated. The chimney is furnished with a spark-trap, so constructed that the sparks are turned downwards into the trap, while the smoke, from its buoyancy, rises. It is also furnished with an ash-pan, well adapted to prevent accidents from fire: the ash-pan contains about three inches of water, so that the ashes falling through the bars, fall direct into the water, and are thus slaked. The front of the ash-pan is furnished with a quadrant-regulator, which closes up securely when the men leave off for their meals; which is a saving of fuel, and at night a great security. The thrashing part is made a great width, to thrash the straw sideways, in order for its being battened: this gives an appearance of bulk to the machine that it otherwise would not possess. The thrashing part is furnished with rollers; so essential to clean thrashing. These are frequently dispensed with, to enable the engine to do more work, but at a sacrifice of good thrashing. It is capable of thrashing from 50 to 100 quarters per day, depending upon the length of the straw, &c., with a consumption of about 8 cwt. of coals. Price 245*l.*

By a reference to the time each of the engines worked, it will be perceived that Messrs. Cambridge's and Ryland and Dean's alone continued in action for the whole space of time allotted for the trial by the Judges. This may in a great measure be accounted for by the hurry in which some of the engines were got up preparatory to the exhibition, and by the new straps which several of the exhibitors used. Every engine worked its own

thrashing-machine, a circumstance most favourable to the level working of both machines: nevertheless the writer cannot but consider that all the machines were driven too rapidly; and, indeed, an accident occurred to Cambridge's thrashing-machine at the conclusion of the ten minutes, which providentially was not attended with loss of life, but which demonstrates the danger of driving a machine too rapidly, as the material of which the drum was composed in all probability not being strong enough to withstand the centrifugal tendency, the whole of the cylinder, torn to pieces, was driven out of the machine, and in its transit through the air knocked off the cap of the person who was feeding the machine.

Ploughs.—No fault whatever could be found, by individuals sincerely desirous of testing the value of these implements, both in light and heavy ground, with the choice which was made of Mr. Pickering's farm at Moulton Park, and the fields of Messrs. Seaby and Green adjoining the Rail Ground: the former land being heavy clay, the latter good convertible soil, well adapted for the trial of all the light implements. Owing to the dry weather which prevailed, and the consequent stiffness of the clay, very many of the ploughs which were selected for the private trial were broken, and, of 24 ploughs originally tested, but 10 were put aside for the public trial in the heavy land. The following is the report of the Judges relative to the trial of Ploughs at Moulton Park:—

"The method adopted for trying these implements was to start them at equal distances from each other. Ten or twelve of these made very indifferent work, while that of the remainder was very satisfactory, considering the dry and baked state of the land. It was clear from the commencement that the old Y. L. plough invented by Messrs. Ransome, with an improved mould-board, invented by the exhibitor, Mr. Busby, performed its work in a superior manner. Although the land was so tenacious, this plough worked more than eight inches deep, and turned the furrow-slice in good form; the land-side was also very cleanly cut, and very level. The Judges had no difficulty in coming to a decision in favour of this plough. The next best were those made by Howard and Sons, and Sanders and Williams, and Samuel Taylor, of Bedford."

The prize plough of Mr. Busby is thus described in the catalogue:—"A two-wheeled plough, invented, improved (with Ransom's truss-beam), and manufactured by the exhibitor for strong land. This implement is capable of working 12 inches deep when required; and with a lighter mould-board will not be found too heavy to be used as a two-horse plough. Prize 5*l.*"

The plough made by Messrs. Howard and Sons was the same

as that exhibited at Newcastle, which took the two 10*l.* prizes last year, having been found the best both in light and heavy land; it is made entirely of iron, principally wrought; is sufficiently strong for 4 horses, as well as easy of draught in general work for a pair; it can be worked either with or without wheels, or with one, as required. It has a broad share, fitting it for paring turf and stubbles; also a share for subsoiling, and another of a triangular form for ploughing between the rows of beans or root-crops. It may be had with a furrow-turner for extra deep ploughing; or with malleable iron or steel furrow-turners. Price 4*l.* 16*s.*; if fitted with skim coulter, 6*s.* extra.

Messrs. Sanders and Williams' plough was a patent wrought-iron plough, with two wheels, W.S., fitted as a swing or wheel plough for two, three, or four horses. The inventors have made several improvements in this plough. The mouldboard or furrow-turner is entirely new, the bearings of which have an equal pressure from point of share to heel of breast, which gives lightness of draught, and also causes the furrow-slice to be turned over without breaking. Price 4*l.* 15*s.* With steel breast 14*s.* extra; with skim coulter 5*s.* extra.

For the trial of ploughs in light land there were 22 selected; the work done by all except one or two was very excellent, so that the Judges were obliged to examine the work scrupulously for the purpose of coming to a correct decision; and ultimately gave the preference to the plough made by Messrs. Howard and Son, of Bedford. The Judges were quite satisfied with the numerous and excellent qualities of this plough, which did great credit to its makers. The next best were those made by Mr. John Adams, of Far Colton, near Northampton, and Mr. Busby, Newton-le-Willows, Yorkshire.

The prize plough is thus described in Mr. Howard's catalogue:—A patent iron plough, with two wheels, marked S. A. (No. 2, maker's list), invented and manufactured by the exhibitor. On the same principle as No. 1, before described under the head of heavy ploughs, but with a new method of fixing the wheels, by which means the width of the furrow-wheel may be altered more readily than upon the old plan. It is also superior to the original method for deep ploughing, and upon dirty land, where the soil accumulates upon the old sliding axle. Price 5*l.*; if fitted with skim coulter, 6*s.* extra.

Mr. John Adams's is an iron plough with wrought frame, capable of turning a furrow from 3 to 12 inches deep with ease. It has also a lever-bar, so that the share may be put in and out of the ground with ease and firmness; the share being thus capable of being worn up to the last bit, instead of being, as is usually the case, rejected when half worn. Price 5*l.* 5*s.*

Mr. Busby's was a two-wheeled plough, invented, improved, and manufactured by himself, adapted for all descriptions of soil, with a moveable nose-piece, upon which the shares are placed, which can be set more or less to land, with more or less pitch: this has been found an advantage where cast-iron shares are used, for, as they wear down, the plough will still retain the same hold or inclination towards the soil.

Scarifiers.—In the construction of these implements considerable improvement has taken place. Seventeen were selected for trial; and as the prize was specifically offered for the best scarifier, the Judges did not think it necessary to put these implements to any other test than that of scarifying: they are, however, of opinion that henceforward the word grubber should be combined with scarifier in the specification for the future prizes, as scarifying appears to be comparatively unimportant when compared with the subworking of the soil.* The state of the ground was very much against the operation of scarifying, being so exceedingly hard that very few of the implements would work the depth required by the Judges, some going too deep, others not entering the ground at all.

An implement invented by Arthur Biddell, and manufactured by Ransomes and May, working with seven tines, was considered by the Judges to make the best work. It was kept the depth required, and without any visible variation during the time it was under their inspection.

The next best was the Uley cultivator, manufactured and exhibited by Mr. Grant, of Stamford. The remainder, though well calculated for grubbing, were inferior to the above in scarifying.

The patent scarifier to which the prize was assigned covered 4 feet 8 inches; from its improved construction the tines can be shifted to different distances apart, and thus be readily adapted to various modes of tillage; it is made principally of wrought iron. Price 18*l.* 18*s.*; delivered in London, 19*l.* 15*s.*

The implement exhibited by Mr. Grant was the wrought-iron five-tined Uley cultivator. Price 11*l.* 11*s.*

Harrows.—The prize was awarded to Sanders, Williams, and Taylor, of Bedford. There was nothing new amongst these implements, nor has the slightest improvement been effected for the last four years. They do their work as seed-harrows for finishing after the drill very well; but the Judges consider the tines work too near to each other to move the ground deep enough for the

* The Stewards perfectly agree in the justness of this last observation; but, instead of hereafter combining the word 'grubber' with 'scarifier,' would recommend the Council to offer a distinct prize for cultivators or grubbers, to which the greater part of the money allotted to this class of implements should be given.

reception of the seed: they would therefore suggest to the Council to offer one prize at the next meeting for the best harrow for preparing the land for the drill, and another for that calculated most effectually to cover the seed after the drill. By such alterations in the premiums some improvement in all probability will be effected, so as to enable those implements to break up the land considerably deeper with the same labour to the horses as at present.

Messrs. Sanders, Williams, and Taylor's harrows were a set of patent four-beam diagonal iron ones, invented by Mr. Samuel Taylor, of Cotton End, improved and manufactured by the exhibitors. These harrows obtained a prize of 5*l.* at the Derby meeting, 1843; also at the Southampton meeting, 1844, and at Shrewsbury, 1845. Their form is diagonal, and the set consists of three, and are drawn by two horses; the teeth are so constructed that each cuts a separate track. The draught being from the centre gives them an advantage over any other mode, and is so arranged that, if one horse moves more forward than the other, the harrow is not put out of its working lines by it. Prize 4*l.* 15*s.* Iron draught-bar, per set, 10*s.* extra.

The best Skim or Paring Plough.—This prize was awarded to an implement which the Judges consider will be found very valuable; invented by Mr. Thomas Glover, of Thrussington; improved and manufactured by Thomas Johnson, of Leicester. It was placed in competition with two others over a piece of uneven ground, in one place falling 10 inches, and again rising 2 feet, in a distance not exceeding 5 feet in length. The other ploughs on entering the hollow part came to the surface, whilst Johnson's preserved the same depth through the hollow as over the ridge. The Judges were of opinion that this implement is calculated to supersede the hand-spade in paring old grass-land. The quantity of land a man and pair of horses can get over in a day without being at all distressed they consider may be about two acres, where no material obstructions occur; it is also adapted to pare stubbles, and is calculated to plough a common furrow when required. Price 5*l.* 10*s.*

Subsoil Pulverizer.—The prize was again awarded to an implement invented and manufactured by the late Mr. J. Read, of Regent Circus, London. Ten implements were selected for trial. The ground was exactly in that state in which it is generally recommended that a subsoil-plough should be used. Most of these ploughs worked well, but were rather difficult to hold. The Judges were glad to observe so much improvement in this class of implements, which are daily coming into more general use, and will as their value becomes better known. The second best was made by Mr. James Comins, Southmolton, Devon.

The price of Mr. John Read's subsoil pulverizer is 5*l.* 5*s.*, and it obtained the prize of 10*l.* at Southampton, Shrewsbury, and Newcastle-upon-Tyne. It works immediately after the common plough, and is of easy draught.

Mr. James Comins's subsoil pulverizer is made very light, combined with great strength, and is light in draught. It will pulverize from 1 to 13 inches in depth below the common furrow. The pulverizers can be worked one below the other, or all three can be worked at one depth: this is an advantage, as it will pulverize the furrow on the top very much, and will work with the mould-share under, and the land will be laid open much longer by working the hind or mould pulverizer 4 or 6 inches below the two front pulverizers. This pulverizer can be worked with two, three, or four horses, according to the depth or roughness of the land. Price 3*l.* 10*s.*

*Drain Ploughs.**—Of this description of implement exhibited, the Judges selected 4 for trial; but as the land was in a dry crumbling state, there was no possibility of testing their merits. The Judges would recommend to the Society, should they offer a prize at future meetings for this implement, to select a more proper season for the trial of them: the months of November or December, when the land has absorbed a great quantity of moisture, is the best time for trying them; and the report could be published in time for the information of persons desirous of using them during the winter and spring months, when they are worked to the greatest advantage. Under the circumstances this prize was withheld.

Ploughs for filling in Drains.—The quantity of the soil removed to the surface by the drain-ploughs was so small, that the Judges thought it unnecessary to try these implements; they therefore recommended them to be kept for a deferred trial, when they may be enabled to test them more efficiently.

Machines for Haymaking.—Although no prize was offered for this description of implement, the Judges considered Messrs. Smith and Co.'s, of Stamford, the most complete machine; it is raised and lowered to the ground as the crop may require by means of a screw, which is very simply adjusted, and may be altered most expeditiously.

Horse Hoes.—No prize offered; but the Judges awarded a silver medal to the Messrs. Garrett for their patent horse-hoe, one of the most valuable implements used in agriculture. Price 18*l.*; a smaller description, 16*l.* This implement was awarded prizes

* 'I very much regret that the Society has been induced to offer rewards for these implements, which never can be used economically in draining. The prize will only lead to expense on the part of the manufacturers, and disappointment to all.—J. Parkes.'

at four different meetings of the Royal English Agricultural Society. It is formed for the purpose of hoeing between the crops of wheat, barley, turnips, or mangold-wurzel, not drilled less than 7 or 8 inches apart; and at the proper season will perform its work in a more effectual manner and at less expense than can be done by hand.

Clod Crushers.—Amongst these implements there was nothing new; it was, therefore, considered unnecessary to take Mr. Croskill's crusher from the yard, as its merits are everywhere so well known and appreciated.

Drills for general purposes.—These implements were this year of a very extraordinary description, which entitle the makers to no small commendation; those of Mr. Hornsby were of superior workmanship, and were the only ones in the least approaching the prize-drills of Garrett. In the private trials the manure was of a coarser description than that used at the public exhibition, which accounts for the little difference then observed by the Stewards in the working of the drills. In Garrett's drill there is an internal arrangement so constructed as not to require the careful preparation of the manure, as it actually tears the manure in pieces before leaving the box, rendering it almost impossible for it to choke. Such is the account given by the Judges; but the writer of this, who has been accustomed for three or four years to inspect the filling of the manure-boxes before trial (a most essential office in a Steward—as, in the enthusiasm caused by the anticipation of the trial, the machinist's men, unless closely observed, will deceive the most wary in managing to introduce into their manure-boxes that particular description of manure, and no other, which their drill is most competent to deliver), happened at this particular moment to be absent; and he was informed that Garrett's drill was already filled when one of his brother Stewards arrived with, of course *nominally*, the coarser description of manure, with which Hornsby's drill, under the eye of the Steward, was charged. The difference of the delivery at the private trial was certainly extraordinary; Garrett's drill performing its delivery, and that well, in a much shorter time than Hornsby's. The private trial, however, was not, from the circumstances detailed, satisfactory to the Stewards, and occasioned some little murmuring amongst the implement-makers; the Stewards, therefore, determined to give these two drills a perfectly fair trial under their particular inspection on the day appointed for the public exhibition. They were tried, then, both with a fine and a coarser description of compost, the latter mixed under the Stewards' direction, whilst each party exhibiting inspected the operation of the other. Precisely the same weight and the same description of manure was placed in each manure-box; and the result of the trial was, in the opinion

of the Stewards, so nearly even, as would fully have justified the Judges in awarding the prize either to Mr. Garrett or to Mr. Hornsby.

Messrs. Garrett and Son were awarded prizes for the same description of drill at Liverpool, Derby, and Southampton. The most recent improvement in its construction consists of the application of Stratton's patent hollow wrought-iron for the cells or side-frame of the drill instead of cast iron, whereby much greater strength is obtained without occupying so much space, whilst it allows the wheels to come nearer the drill-box : in addition to which a dial-plate is affixed with a regulating screw, by means of which the gear-wheels can be more easily regulated for the delivery of grain. It is fitted with double-actioned levers for depositing corn and manure, either together or through separate conductors, burying the manure at any required depth below the surface, and placing as much soil above it as necessary before the seed is deposited. Price 46*l.* 12*s.* 6*d.*

Mr. Hornsby's drill has received 4 prizes from the Society. It is fitted as a 10-coulter seed and manure drill, and 11-coulter corn and seed drill. The alterations made in this machine since last year, when it obtained the premium, are—that the manure barrel and stirrer turn either way, whilst the shape of the manure-box is altered and improved. Price 53*l.*; if fitted with fore-carriage and an improved steerage, 4*l.* 10*s.* extra.

Drill-presser.—Mr. Hornsby's drill-presser is a good implement, and fully entitled him to the prize: it has received the Society's premiums twice before; and is a two-row drill-presser, with coulters to conduct the seed and manure to the ground. The same alterations have been made in the manure-box since its last exhibition as that described in the drill for general purposes. Price 16*l.* 10*s.*

Turnip Drill on the Flat.—The prize was awarded to the Messrs. Garrett for a four-row lever-drill for turnips or mangold-wurzel. The drill had before received a Society's prize at Cambridge. This drill is also adapted for drilling beans, peas, and carrots with manure at any intervals apart, which is an addition to the implement exhibited last year. The same additions as regards the cill and regulating screw have been made as those described in the general-purpose drill manufactured by the same exhibitors. Price 26*l.* 10*s.*

Turnip Drill on the Ridge.—Messrs. Garrett likewise obtained this prize for a patent two-rowed lever-drill of the same description as that which obtained the prize in 1842, with the alterations as before described in the drills for general purposes and that on the flat. Price 23*l.* 5*s.*

The Judges remark that Mr. Hornsby's two-ridge turnip-drill

was a very complete one; but that from some mishap the following roller would not work at the trial, which without doubt in that instance lost him the prize. The implement was the same as that which received the deferred premium at Pusey. Price 24*l.*

The Judges have to report very highly of Garrett's Registered Kent Drill, which was tried with coarser manure than either of the others, and proved itself far superior in drilling that kind of manure; it was not, however, calculated to drill so small a quantity as would be required of the fine kinds of artificial manure, such as guano, rape-cake, bone-dust, &c., otherwise it would have been entitled to the prize. The Judges regretted that no award could be made to this drill. Price 36*l.* 15*s.*

Broadcast Manure Drill.—Mr. Croskill gained this prize for his portable manure-drill, 6 feet wide; much improved since it was exhibited and gained a prize at Bristol, by the substitution of an iron instead of a wooden roller, which distributes more equally, and is not liable to shrink. It will contain 8 bushels of manure, and distributes quantity in proportion to the speed of the horse. Price, delivered in Hull, 10*l.* 10*s.*

The Judges remark that for pulverized manures this drill appears unequalled; but that one exhibited by Mr. H. Smith, of Stamford, has novelty, and when brought into working order will be an implement for distributing rough manure far preferable to the more complicated manure-drills.

Horse Seed-Dibbler.—Prize awarded to Mr. Newberry for his 7-rowed dibbling-machine; the same as exhibited last year, only improved in the mode of opening the dibbler. The Judges remark that, perfect as this machine is, the variation of the seeds deposited in each hole was from 1 to 8. Price 60*l.*

Corn-dressing Machines. — The dressing-machines taken for trial were seven; the corn used of the roughest description. The prize was awarded to Mr. Cooch; but Wheatley's machine is very good, and would have been, perhaps, more than a match for Cooch's, but for a defect in the hopper. The following were the results of the trial:—

	minutes.	bls.	pks.			Price. £.	s.
Caborn	3	3 nearly,			Tail large	14	0
Groundsell	3	2	$0\frac{1}{4}$		Small	12	10
Nicholson	3	2	$0\frac{1}{2}$		Very large	11	0
Wheatley	3	3	2		Very good indeed	14	10
Hornsby	0	0	0		A good machine, but no trial	13	0
Cooch	3	7	1	Riddled first	Very little tail	18	0
Choyce*	3	2	0	Riddled first	A bad machine	9	0

Since Mr. Cooch's machine was exhibited at Shrewsbury, the following alterations have been made. The blast has been in-

* No chance.

creased $\frac{1}{4}$ by altering and opening the throat by the removal of obstructions from the passage. A slide has been placed above the aperture which admits air to the fan, which can be let down, thus reducing the blast for the purpose of dressing light grain one-fourth. The shape of the inclined feeding-board of the hopper has been altered, so as to deliver the corn immediately over the roller; the back part of the hopper, which was formerly more oblique, is now formed with a canting incline; the sides of the hopper are now perpendicularly flush; the motion working the riddle has been altered from a crank to a pair of mitre pinions, producing the same motion with four fewer bearings. Price 16*l.*

Steaming Apparatus.—Prize awarded to Mr. Robinson as the most economical and useful of the three tried; in the cookery of linseed and linseed-compound it will be found of essential service, as in the old plan of boiling there is considerable waste from its baking on the sides of the caldron, but in this case by simply turning off the steam the boiling ceases. The improvement made upon that which was exhibited and gained a prize of 5*l.* at Newcastle last year consists in the water-fountain being placed above the boiler and surrounding the flue for heating the supply of water, by which means the steam is kept continuously up, the water being supplied to the fountain by pails. The fireplace has likewise been enlarged for the purpose of using wood and turf as well as coal. Price 9*l.* 10*s.*

One-Horse Cart.—Prize to Mr. Stratton. The Judges state that this was a sore trial, for, although Howard's is undeniably the best cart on the ground, it cannot be called a one-horse cart; and consequently they came to the opinion that Mr. Stratton's cart, fitted with his liquid-manure cistern, was the best and most generally useful cart under this head. Mr. Stratton's harvest-cart is also particularly worthy of commendation; as are his new iron wheels.

The one-horse cart was the same as that to which a medal was awarded at Derby, and a prize of 5*l.* at Southampton, the sole improvement being the substitution of a wrought-iron liquid-manure cistern for the cask used at Southampton. Price of the cart fitted only for solid manure, 17*l.* 17*s.*; if with cistern, 25*l.*

Linseed Crusher.—Six of these useful implements were tried: the tabular form, p. 350, will show their work.

In all the above machines there is great merit; and had Mr. Sharman's machine been as perfect in its feeding part as in its crushing, it would have had a good chance of the prize; but Mr. Ferrabee's machine, being a perfect article in all its parts, and at the same time very expeditious, was awarded the prize.

The following is the description of the prize implement:—A patent machine for crushing linseed, bruising oats, and splitting

beans; invented by George Parsons and Richard Clyburn, of West Lambrook, Devon, and Uley, Gloucestershire; manufactured by the exhibitor. This machine is fitted with a large and small roller, with a series of grooves turned in each, in the form of a V, and fitting each other. The sharp edge of the V penetrates the seed or grain, while the velocity of the grooves varying, produces a grinding motion. The grooves are kept clean by scrapers attached to the frame, so that the work is quite uniform. Price 12*l.* 10*s.*

Maker.	Stand.	Article.	Price. £. *s.* *d.*	Power.	Quantity.	Time. Min. Sec.	How done.
Messrs. Ransome & Co.; exhibited by Croskill.	43	70	5 5 0	2 men	1 gallon	2 0	Well done.
Mr. Nicholson .	77	7	5 15 6	2 men	1 gallon	4 10	Exceedingly well done.
Mr. Garrett . .	99	24	5 5 0	2 men	1 gallon	4 0	Well done.
Mr. Stratton . .	105	10	6 10 0	2 men	1 gallon	$2\frac{3}{4}$ 0	Rather mealy.
Mr. Sharman, exhibitor; Messrs. Bond, makers.	104	49	13 0 0	2 men	1 gallon	1 0	Well done.
Mr. Ferrabee . .	114	12	12 10 0	2 men	1 gallon	$1\frac{3}{4}$ 0	Beautifully done.

Weighing Machine.—Prize awarded to Mr. H. G. James for nearly a similar implement to that which obtained prizes at the Derby and Shrewsbury meeting: it is upon wheels and quite portable, weighing up to 21 cwt. Price, wheels included, 20*l.*

Model of Rick-yard.—Prize withheld.

Set of Harness.—Prize withheld.

Gorse Bruiser.—Prize withheld.

Grinding Mill.—Prize withheld.

Chaff-Cutters.—Eleven chaff-cutters were selected by the Judges for trial. (The tabular statement received from them will be found in the following page.)

There appeared to be a considerable improvement in the construction of the boxes; and although there is merit due to most of them, yet the Judges were of opinion that the chaff-cutter No. 5 of the stand 58, p. 66, invented by Mr. Cornes, of Barbridge, Nantwich, Cheshire, was the best, and therefore awarded the prize of Ten Sovereigns to him.

The prize implement may be thus described:—A chaff-cutting machine, with three knives, invented and manufactured by the exhibitor. This machine is similar in principle to the one which obtained prizes at Shrewsbury and Newcastle, but larger in size;

Stand.	No.	Maker.	Power.	Price.	Length of Chaff.	Time at Work.	Quantity of Chaff.	—
				£. s.		Minutes.	lbs.	
8	7	Richmond .	1 man	10 10	$\frac{3}{8}$ of an inch.	3	20	Good work.
28	1	Gillett . .	1 man	10 10		3	20	Excellent.
42	2	Cornes, Market-Drayton, Salop.	2 men	7 10		3	31	Good.
45	3	Smith, of Northampton.	2 men	11 0		3	35	Not hard work for the men.
48	31	Howard & Son, Bedford.	2 men	8 10		3	30	Easy work for two men.
54	23	Barrett & Exall, Newbury.	1 man	5 10		3	12	Easy work.
58	5	John Cornes, Barbridge.	2 men	14 0		3	$40\frac{3}{4}$	Easy work and excellent.
82	24	Sanders and Williams, Bedford.	2 men	12 12		3	40	Good work.
86	12	Smith & Co., Stamford.	2 men	11 0		3	36	Ditto.
104	37	Stanley . .	2 men	11 11		3	31	Ditto.
104	40	Stanley . .	1 man	4 0		3	18	A hard box; the cut was of irregular length.

to be worked either by two men or machinery: breadth of cut 12 inches, depth $2\frac{3}{4}$ inches, and makes five different lengths of chaff—two for horses, two for cattle, and one length of 4 inches for litter. It is also fitted up with an additional pair of feeding-rollers, which regulate the materials before entering the front ones next the cut, whereby the danger of the feeders getting their hands entangled in the hay or straw is entirely avoided when the machine is driven by steam or other power at a great velocity. Price, delivered at Barbridge, 14*l.*

Two machines for cutting straw for litter were commended to the notice of the Council by the Judges:—

Stand.	No.	—	Name.	Power.	Price.	Length.	Time.	Quantity.	
					£. s.	Inches.	Minutes	lbs.	
118	101	5	Smith	1	7 0	6	3	28	Easily worked.
147	114	5	Fewlen	1	10 10	4	3	15	Ditto.

Thrashing Machine.—Eight machines were selected for trial by the Judges, and the general goodness and quality of the work will be better estimated by the perusal of the report of the Judges than from any lengthened eulogium of the writer: suffice it that

the two best upon trial ran so close to each other that the decision was postponed for a second day's trial, when Messrs. Garrett's machine was declared the best under the following report:—

"The thrashing-machines submitted to our notice were Garrett's and Hornsby's. The latter, a six-horse power with bolter barn-works, thrashed 50 sheaves in four minutes forty seconds; price 90*l.* The former, a four-horse power with bolter barn-works, thrashed the same in three minutes fifty seconds; price 60*l.* 10*s.* The grain in both cases was the same; but Garrett's thrashed the straw cleaner, and without breaking it in the least. We are of opinion that both are good machines. The prize one has a parallel movement in the concave,—a great improvement, which would have entitled it to the prize if they stood on equal ground; but price, time, and work are also all in favour of Garrett's."

For the general working of the machines see next page.

The thrashing-machine which obtained this well-contested prize was a four-horse power bolting thrashing-machine, invented and manufactured by Garrett and Son. The prize of 25*l.* was awarded to this machine at the Royal Agricultural Society's Meeting at Newcastle, 1846. It thrashes every description of grain, and is warranted not to injure the corn, or bend or bruise the straw, so much as thrashing with the flail. It is fitted with R. Garrett and Son's patent cylindrical wire drum and registered iron levers or shafts. In districts where the straw is sold this will be found a most invaluable implement. Price, as a portable machine complete, 60*l.* 10*s.*; ditto, as a fixture complete, 53*l.* 10*s.*; extra if fitted with the registered iron levers, each lever 10*s.*; ditto of the thrashing part to be applied to steam or water power, fitted with pulleys, 27*l.* 10*s.*

The thrashing-machine which the Judges in their report particularly commended to the Council was Mr. Ferrabee's, described as a portable thrashing-machine, for two or three horses; improved and manufactured by the exhibitor. The horse-power of this machine will admit of two or three horses being applied to it. It is mounted on a pair of wheels, and furnished with a lifting-jack. The machine is constructed with iron frame, drum, and concave, the thrashing part being principally of wrought iron. The regulation for different kinds of grain is effected by a handle attached to a bar with eccentrics on it, and which always maintain the concave and drum parallel to each other, their proximity being shown by an index. Price 47*l.* 10*s.*

Churns.—Four of these implements were tested, and each produced very good butter; it was a neck and neck race, and the prize was awarded to Mr. R. Robinson, for a churn similar to that for which he obtained the prize at Newcastle last year:

THRASHING-MACHINES.

Stand.	No.	NAME.	Horse-Power.	Price. £.	s.	d.	Time. Min.	Sec.	Sheaves.	Quality of Work.	State of Grain.	State of Straw.	—
43	73	Crosskill .	4	45	0	0	3	22	50	Not quite clean.	A little broken	Broken	Very hard work for 4 horses.
46	14	Hornsby .	6	90	0	0	2	55	50	Ditto	Ditto	Ditto	Rather hard work for 6 horses.
46	15	Hornsby .	6	42	0	0	2	45	50	Quite clean	Very little broken	Not much broken	This machine made excellent work, but very hard work for horses.
49	1	Knight, of Northampton.	4	69	0	0	3	33	50	Clean	Broken	Very much broken.	Very hard work for 4 horses.
66	1	Grasby .	6	95	0	0	3	0	50	Not clean	Ditto	Broken	Exceeding hard work for the horses.
99	15	Garrett .	4	60	10	0	4	0	50	Clean	Little broken	Not broken	This machine made excellent work, and 4 horses were able for it.
114	8	Ferrabee .	2	47	10	0	10	0	50	Clean	A little broken	..	This machine made excellent work. We *commend it to the notice of the Council.*
116	8	Langdale .	4	65	0	0	4	40	50	Clean	Ditto	Greatly bruised.	Excellent work, but rather hard for 4 horses.

the only improvement effected since being a small opening left, which allows the heated air produced by the rotatory motion of the blades to escape, rendering the butter firmer. Price 4*l.*

Pipe and Tile Machines.—The merits of the drain-tile machines taken for trial are perhaps pretty equal; not so their price, varying from 35*l.* to 12*l.* 12*s.* Mr. Scragg's is the most powerful, producing tiles and pipes at an astonishing rate: from 25,000 to 30,000 1⅛-inch pipes might be produced by this machine (provided no stoppage took place) in ten hours; but, it being quite impossible to remove so large a quantity, or to find shed-room when drying, we think a machine so costly, and requiring so much extra labour, cannot be entitled to a prize. Ainsley's is a most beautiful machine, but, not having any means of screening the earth, had no chance in the competition. The cutting apparatus of this machine is well contrived, it being impossible to produce tiles of unequal length. Mr. Webster, of Hornsdown, exhibited a good machine, but, not being prepared with hands to work it, we are unable to form any opinion now, but can speak highly in its favour from personal observation elsewhere. The prize was awarded to Mr. Sanders's simple, strong, and cheap machine, which, being but a one-ended one, has a slip gear allowing the piston to fall back instantly for recharging: it has also something original in the lid leverage, which certainly has the effect of removing much of the confined air.

The following is a table of the work performed, the power used, the time in which the work was performed, and the price of the different machines:—

NAMES.	Pipes.	Inch.	Tiles.	Inches.	Horse.	Men.	Boys.	Screened.	Price. £.	s.
William Swain	63	1½	49	2½ by 2	..	..	3	Same time	17	0
Thomas Scragg	194	1⅛	108	2½ by 3½	..	2	1	First	35	0
Robt. Scrivener	46	1½	withdrawn		..	..	..	..	35	0
Henry Clayton	145	1½	66	2¼ by 3½	..	2	3	First	26	0
John Franklin	55	1½	..	..	1	1	2	Same time	35	0
John Miles .	49	1⅝	no tile-die		..	1	1	First	21	0
Sanders . .	62	1½	48	2¼ by 2¾	..	1	1	Same time	12	12
Weller . .	165	1½	99	2¼ by 2¾	..	1	2	First	25	0

It is difficult from this table to understand the grounds of the Judges' decision, for, although the precise time at which these machines were worked is not given, yet it is apparent, whatever the time may have been, that Scraggs, Clayton, Miles, and Weller performed the task in less time than Swain, Franklin, or Sanders.*

* The numbers of pipes made, as given above, must not be taken as a

Clayton's machine is certainly expensive in the working, but the great desideratum in tile-making, as well as in all operations whether agricultural or manufacturing, is to get over the work fast and well. The description of the machines exhibited by Scragg, Clayton, and Weller are therefore appended to this report, particularly as Clayton now delivers the tiles horizontally as well as vertically, which cannot be regarded but as a great improvement. It will be seen likewise in the subjoined statement that Messrs. Sanders and Williams, to whom the prize was adjudicated, do not themselves profess to work with less than *one man and two boys.* The following is their description of the implement:—

A machine for making draining-pipes and tiles, invented, improved, and manufactured by the exhibitor: the improvement consists in enlarging the spur-wheel in diameter, which gives additional power to the man turning it. The compartment which receives the clay has likewise been enlarged, which empowers the man working the machine, from the greater quantity of clay now contained in the box, to manufacture a larger quantity of pipes or tiles in the same given time than he could have done with the smaller box. The machine is calculated to make 6000 1½-inch pipes per day with *one man and two boys.* Price, with one die and one horse, 12*l.* 12*s.*

Each end of Mr. Scragg's machine is formed into a square box lined with plates of iron, the lids of which open on hinges to admit of the clay being put in, and when shut are secured by cross bars. At the outside end of each box is a frame of cast-iron, made to receive and hold fast the dies which give shape to

proof of the ability of the machines. Some makers were better provided with hands than others; several worked at a desperate racing pace; while others proceeded at a comfortable working speed. The Judges, after giving the machines the most careful attention, decided in favour of the machine manufactured by Messrs. Sanders and Williams, as the quality of the tiles was excellent, and the quantity made as great as could be dried within a reasonable distance of the machine; and far more than could be burned in an ordinary kiln holding 40,000, even supposing no time to be lost in burning. Ainsley's machines produced, perhaps, the best tiles, but the numbers were very deficient and the labour in working great. It will be seen that three machines produced immense quantities, but the quality was hardly equal to those produced by the prize machine; besides which the drying and burning processes could not be carried on at the same rate: these machines also required greater capital to purchase and work them. Perhaps, after all, too much importance is attached to these machines, as the principal labour in tile and pipe making consists in digging the clay, turning it over, watering, and carrying it to the machine; and subsequently conveying the tiles, &c., to the hacks or shelves; from thence, when sufficiently dry, to the kiln to be set and burnt, and then taken out and stacked for sale. These processes, it will be seen, can only be performed by manual labour.—*Note by Messrs. Everett and Taylor.*

the tile to be made, The rack has pieces of wood at each end, which exactly fit the boxes containing the clay, so that as it traverses backwards and forwards it forces before it the clay through the dies. The rack is of such length that when one end is close to the die-frame the other box is ready to receive its supply of clay. The men working it are made aware when to stop and reverse the motion by a steel spring striking upon a point on the rack. The centre part of the machine contains the wheels, &c. which work the rack, and by which the requisite gain of power is obtained. The frame is called the receiver, and is made separate, for convenience of carriage and moving about; and when the machine is used only for preparing the clay, the receiver is laid aside. The clay is prepared and freed from stones, &c. by being forced through a screen made of wires placed a little distance apart. Awarded to this machine, 20*l.* at Shrewsbury and 20*l.* at Newcastle-upon-Tyne in 1845-6. Price, including twelve sets of different-sized dies, 35*l.*

Mr. Clayton's machine has the following description in the catalogue:—A patent hand-working machine for the manufacture of draining-pipes, draining and other kinds of tiles and bricks; invented, improved, and manufactured by the exhibitor. A hand-working machine for the complete manufacture of draining-pipes from one inch to six-inch bore, all kinds and shapes of draining-tiles, flat tiles, and bricks. The patentee begs to observe that this machine has undergone considerable and important improvements since the Newcastle show, the chief points of which are that it is now wholly made of iron, and constructed for working either upon the "vertical" or "horizontal" plans, *i.e.* combining both plans in one machine (an advantage which cannot be offered by any other manufacturer of this description of implement)—a combination rendering the machine applicable to the entire manufacture of a tile and brick yard, with all the advantages of strength, simplicity, durability, and productiveness, so desirable in a machine of this kind. The machines are also fitted up so as to be either "locomotive" or "stationary." Although the superiority and efficacy of the "perforated metallic gratings" are now so very generally known for the purpose of perfectly freeing or separating clay from stones, roots, and other hard substances, without seignorage or royalty, the purchase of a machine includes the free use of it. Machine to work on the vertical plan (without dies), price 26*l.*

Mr. Weller's patent drain pipe and tile machine is described as invented by himself, and improved and manufactured by Garrett and Son. A prize of 5*l.* was awarded for this machine at Newcastle in 1846. This machine is for the purpose of making every description of pipes and tiles used for draining, also of plain and

ridge tiles for buildings, and copher-drain tiles. It is constructed entirely of iron; and, being mounted on four wheels, may easily be drawn from place to place, and worked in the sheds wherever the tiles are required to be laid. The machine is made with two cylinders vibrating on their centres, out of which the clay is alternately forced, by means of horizontal pistons, through the dies that are attached to them. When the cylinders are emptied, they fall from their horizontal into an upright position, for the convenience of filling. The machine is worked by a man and boy, with a lever purchase. Price, including two dies, with tables and mandrills complete, 25*l.*

Draining Tools for Clay Land.—Prize awarded to Mr. Clayton. Price: polished blades, 2*l.*; black blades, 1*l.* 15*s.*

Draining Tools for Friable Land.—Prize given to Messrs. Mapplebeck and Lowe. Price, for whole set, 35*s.* 6*d.*

Draining Tools for general Draining.—Prize carried off by the same firm. Price per set 1*l.* 3*s.*

The Judges generally reported of these implements, that they were well-made, good, and serviceable tools, and adapted for working upon the different soils to which they were applicable.

Miscellaneous Department.

The Judges of this department report that, in reference to the 454 miscellaneous articles exhibited, for which only six medals were allowed (and some of those were granted by other Judges), much might be said; particularly as to the policy of having Judges to go through them at all, and disappointing the hopes of those exhibitors who really had some useful articles; and they suggest that, for the future, it would be better either to leave it to the Judges to award such medals as they may think fit, to give a greater sum at their disposal, or to withdraw medals altogether for miscellaneous articles; either course of proceeding would in their conception be more satisfactory to the Judges and useful to the Society. With regard to the character of the miscellaneous articles, there were many, very many, useful; and they regretted that, after three days of hard work, they had so few and such small rewards or distinctions to distribute. The few they were enabled to give were strictly of an agricultural character, viz. to a horse dray-rake, turnip-cutter, fire-engine, an oil-cake breaker, and a clover and rye-grass distributor, the two latter of which only presented novelty as well as merit.

Silver Medals were distributed to—

Mr. Smith, *for the best clover-seed and rye-grass barrow, upon a new construction,* admitting the two kinds of seeds to be sown at the same time by the delivery of them from chambers, thereby remedying the defect hitherto existing from the two sorts of

seeds being mixed, viz. the clover-seed settling to the bottom of box. Price 6*l.* 10*s.*

Messrs. Wedlake and Thompson, *for the best oil-cake breaker*, on *a new construction:* it will break the thick American or other foreign or English cake into pieces. It is fitted with a double set of rollers, and is easily regulated to break to any size. Price 6*l.* 10*s.*

Mr. Read, *for the best fire-engine.* Price 60*l.*

Mr. Grant, *for the best horse-drag-rake.* It carried off a prize at Newcastle, and has since been much improved and strengthened in construction. Price, at Stamford, 7*l.* 10*s.*

Messrs. Mapplebeck and Lowe, *for the best Gardner's turnip-cutter.* Price 4*l.* 15*s.*

Messrs. Garrett, *for the best horse-hoe,* patent, and the same that has received prizes at Liverpool, Bristol, Derby, and Southampton. Price 18*l.*

Mr. W. N. Nicholson, *for a very strong machine for breaking oil-cake for beasts and sheep;* the principal advantage of which consists in a simple and effectual arrangement for varying the distance between the rollers, by which they are always kept parallel, the alteration being performed almost instantly, without the least possibility of getting out of order: and also in a novel mode of connecting the breaking-rollers. It is calculated to break almost every description of thick foreign cake. Price 6*l.* 6*s.*

Such is the Report which the Stewards have now to submit to the Council of the exhibition and trial of implements at Northampton; and they cannot but congratulate the Society upon the rapid progress of mechanical science as applicable to agricultural implements which has taken place since the Oxford exhibition. The attendance at the yard and the respective trial-grounds this year evince no flagging of public attention, whilst the orders given to the different manufacturers prove that, in those districts of country in which the appliances of agricultural skill have been supposed to be most deficient, a spirit of inquiry and a determination to improve have been engendered likely to lead to the happiest results, both as regards the cultivation of the soil and the public at large.

P.S.—The following protest was made on the part of the subscribing machinists against the decision of the judges as regarded Mr. Cambridge's portable steam-engine, to which they had awarded the 50*l.* premium:—

At a Meeting of the Exhibitors of Steam Engines at the Royal Agricultural Society's Meeting at Northampton, held this Wednesday, 21st day of July, 1847. Present,

Mr. Ogg, Jun., of Northampton, in the Chair;

Messrs. Barrett, Ashton & Co., of Hull; Mr. Bloxsom, of Gillmorton; Messrs. Ryland & Dean, of Birmingham; Mr. Thos. Johnson, for Self and W. Sharman, and W. P. Stanley;

It was resolved unanimously,

That in the opinion of this meeting the judges are chargeable with great injustice towards the unsuccessful exhibitors of steam-engines in awarding the prize of 50*l*., offered by the Society for the best steam-engine, to the one which, of all those exhibited, they consider the *least* entitled to the prize; and that bearing in mind the determination, so emphatically expressed by the judges, to pay particular attention to the prevention of danger, the consumption of fuel, the pressure of steam, strength and capacity of boiler, and to all points affecting the safety of the public, this meeting are at a loss to account for so flagrant a violation of these principles as the award of the prize to an engine, which, it is notorious, consumed nearly twice as much coal as some others exhibited; was working at a pressure *exceeding* 80 lbs. per inch, and at a speed of from 240 to 250 revolutions per minute. The result of which (as must be anticipated) was the partial destruction of the thrashing-machine, at the imminent danger of all parties employed about it.

2ndly. That this meeting are further of opinion that a deception has been practised upon the judges in the entry of Mr. Cambridge's steam-engine as one of four-horse power, whereas the capacity of the cylinder, viz., 6 inches, with a 12-inch stroke, are only equivalent (at a pressure of steam that may be considered as safe in the hands of inexperienced persons) to about *three-horse power*. That an erroneous impression is thereby created as to the *relative price* of the engine; and that, under these circumstances, the engine is disqualified from competing, and therefore not entitled to the prize.

3rdly. That this meeting are much disappointed that the disposal of the prize for steam-engines has not been deputed to Mr. Parkes, or some other practical competent engineer, and express their determination never to exhibit steam-engines at the future meetings of the Society until such an arrangement shall be made as will ensure them an ample trial and a proper adjudication.

(Signed) WM. BLOXSOM.
BARRETT, ASHTON, & CO.
RYLAND & DEAN.
DAVID OGG & SON.
THOS. JOHNSON.

The Council having taken this protest into consideration, determined temporarily to withhold the prize awarded to Mr. Cambridge, and submitted to the judges two queries, as to the diameter of the cylinder and length of the stroke of the engine in question; to which they replied, that the diameter of the cylinder was 6 inches; the length of the stroke $12\frac{1}{2}$ inches. These measurements were taken from an engine made by Mr. Cambridge, and precisely similar in all respects to that exhibited by him at Northampton, in possession of Mr. Miles, of Leigh Court, near Bristol, the working of which engine Messrs. Morton and Love privately inspected on Monday the 13th of September, and forwarded to Mr. Miles the following report respecting its general working, and reasons for their judgment:—

Whitfield, 14*th September*, 1847.

Dear Sir,—The opportunity which you gave Mr. Love and myself yesterday of making a thorough examination of Cambridge's portable steam-engine (which you have had for 6 months), and of seeing it in full work for 3 hours, has confirmed our previous opinion of its merits, and of its adaptation to agricultural purposes.

The "important data," viz. "the diameter of the cylinder and the length of the stroke," which the Council required of us to enable them to settle the question of merit, form, according to my view of the matter, only part of the elements required for measuring the power of a steam-engine. The Great Britain steam-boat had her steam-engines of 1000-horse power according to *measurement*, but they were never able to work up to 600 horse. The cylinders of the railway locomotive engines are all of the same size, but their power is different, and this difference is neither owing to the diameter of the cylinders nor to the length of the stroke, but to the quantity of water converted into steam per minute at a particular temperature and properly used.

I have enclosed a diagram of the boiler, the safety-valve, the length of the lever, and the weight of the ball, so that Mr. Parkes may be enabled to judge of the pressure of the steam.

The greatest length of the lever is 14 inches; the diameter of the safety-valve is $1\frac{3}{4}$ inches, the weight of the ball is $21\frac{1}{2}$ lbs.; 90 lbs. per square inch is the greatest pressure when the ball is at the end of the lever; but as the weight on the lever was only 10 inches from the fulcrum while it was worked in our presence, the pressure on the square inch was not quite 60 lbs.

The time I saw the engine at work (as I have already stated) was 3 hours: it was driving a 6-horse thrashing-machine, which your man informed us required 6 of your most powerful horses to work before you had this steam-engine, and he said that he can now thrash 48 bushels more per day than ever he did with the 6 horses. During the whole time I was there the safety-valve was never loaded up to 60 lbs. per inch. The greatest number of revolutions was about 150 per minute, and the least 120.

I had the barn clean swept, and thrashed for 10 minutes, and had $5\frac{1}{2}$ bushels of clean wheat measured up. This is at the rate of 330 bushels per day of 10 hours; during the 10 minutes I was beside the engine, no steam escaped the safety-valve; the weight on the lever was just 10 inches from the fulcrum, which is equal to a pressure of nearly 60 lbs. per inch, and the engine made regularly 150 revolutions per minute.

The diameter of the cylinder is 6 inches, and the length of the stroke is $12\frac{1}{2}$, and there was no deficiency of steam to keep the engine at work all the time we were there, and your man informed me there never was any stoppage for lack of steam. The length of the boiler is 8 feet, its circumference outside is 9 feet 2 inches. It is constructed on the Cornish principle: the fire-tube is oval, 2 feet wide and 18 inches high; this space forms the fire-place and the ash-pit. The water is heated in a cistern at the end of the boiler by the heated air, which going from the furnace into the smoke-flue, passes through this cistern: it is heated to about 150° before it is forced into the boiler.

The following table of Mr. Templeton's gives the diameter of cylinder required for one-horse power, with steam at different pressures :—

Number of Horse-power.	Diameter of Cylinder in inches, with Steam at			
	25 lbs. per inch.	30 lbs. per inch.	40 lbs. per inch.	50 lbs. per inch.
1	$3\frac{3}{4}$	$3\frac{1}{2}$	3	$2\frac{5}{8}$
2	$5\frac{1}{4}$	$4\frac{3}{4}$	$4\frac{1}{4}$	$3\frac{3}{4}$
3	$6\frac{1}{2}$	6	5	$4\frac{1}{2}$
4	$7\frac{1}{2}$	$6\frac{3}{4}$	6	$5\frac{1}{4}$
6	9	$8\frac{1}{4}$	$7\frac{1}{4}$	$6\frac{1}{2}$
8	$10\frac{1}{2}$	$9\frac{3}{4}$	$8\frac{1}{2}$	$7\frac{1}{2}$
10	$11\frac{3}{4}$	11	$9\frac{1}{2}$	$8\frac{3}{4}$
Quantity of water in gallons per minute to each horse-power.	·45	·5	·61	·73

I was astonished to see, from a published letter of Mr. Ryland's, that Mr. Hudson had informed him that the prize to Cambridge was suspended. From this circumstance I was induced to look at my memoranda, and there I find this information given to me by one of the gentlemen of Messrs. Ryland and Dean's concern :—"The size of each of the two cylinders is $5\frac{1}{4}$ inches in diameter, and the horse-power is $5\frac{1}{2}$." I objected to this as not indicating the proper power with steam at 50 lbs. pressure ; but the gentleman disputed the point with me. Now, according to Templeton's table, a $5\frac{1}{4}$ inch diameter cylinder is equal to 4-horse power, so that two of these are equal to 8-horse power instead of a $5\frac{1}{2}$ horse power, as stated by them. The value of this statement, as well as of the objections which Mr. Ryland has made to the decision we came to, will, I have no doubt, be taken by you at the full amount of what it is worth.

All the measurements in the above statement were taken in your presence, and you will of course alter any which are not perfectly correct in every part.

I am, dear Sir,

Yours faithfully,

W. Miles, Esq., M.P. John Morton.

XIV.—*On the Cultivation of Flax.* By James MacAdam, jun., Secretary to the Royal Society for the Promotion and Improvement of the Growth of Flax in Ireland.

Prize Essay.

Among the products which are raised from the soil by the industry of man, the various articles of food demand his first attention. The culture of those plants which afford sustenance

to human beings, or to the animals of whose flesh so large a proportion of human food consists, is necessarily his first care on emerging from the nomade or savage state. This is the more imperative in the infancy of a nation, when, from its limited means of intercourse with foreign countries, it is dependent upon the resources existing within its own bounds.

Next to food the supply of clothing is all-important, and is at first exclusively obtained from the skins of animals, or the indigenous productions of the country, rudely fashioned for the purpose. In a more advanced stage of cultivation, an extended intercourse with other nations, and the ingenious application of mechanism to the fabrication of textile substances, cause the use of a variety of materials, the produce of a variety of climates. It then becomes of importance to ascertain whether the country in which such manufacture is prosecuted can produce the raw material, and, if so, whether it can be produced at a cost equal to or less than the import price, or, in other words, if the value of the raw material, as established by the price paid for it by the manufacturer, is such as will enable the native cultivator to realise a profit by its production, equal to that given him by other crops.

This inquiry also involves many minor points, which are yet of great importance in weighing the propriety of obtaining the raw material at home. The quantity of matters forming the food of plants which are abstracted by it from the soil, the amount and nature of the labour required for its production and manipulation, the relation which its home manufacture bears to the same manufacture abroad, are all points demanding attentive consideration.

The animal and vegetable worlds pretty equally divide the supply of the principal articles of clothing required by the human race. From the former we obtain wool and silk; to the latter we are indebted for cotton and flax. Of these four substances, which enter into the composition of at least nine-tenths of the clothing of the civilized world, one (cotton) is the exclusive production of the regions bordering on the torrid zone; another (silk), although it has, to a trifling extent, been cultivated in Great Britain, may also be considered as naturally the production of the same countries, since the silkworm does not thrive so certainly in our climate. A third (wool) is largely obtained at home, and gives employment to a flourishing branch of British farming; yet it is understood that the wool of our islands is inferior for felting to that of foreign countries, and cannot be substituted beyond a certain proportion, or for certain kinds of cloths. The last-mentioned, flax, is the only one of the four for which our soil and climate are absolutely suited, and where a native-grown article might be substituted to a very large extent, if not altogether, for the foreign import.

It becomes, therefore, a question of considerable moment, whether a home-production would be advisable; and the Royal Agricultural Society of England have declared as a subject for essay, "the reasons, general and particular, in favour of extending the growth of flax in this country, and what are the considerations adverse to this practice, the most approved methods of cultivating the plant, the best mode of saving the crop and preparing the flax for market, and in what way the whole or any portion of the seed may be saved with the least injury to the fibre, and how the seed may be most profitably applied by the farmer."

In the consideration of this subject, I shall divide the matter under three heads; first, the demand existing for flax, as the raw material of the linen manufacture; second, the mode of culture and preparation of the plant for this manufacture, and the economy of the seed; and, thirdly, the principal reasons favourable or adverse to its general cultivation in the British Islands.

The plant Flax belongs to the class Pentandria Pentagynia; nat. ord., Griunales; genus, Linum. With but one species of this genus we have to do—Linum Usitatissimum, thus botanically described:—Calyx-leaves egg-shaped, acute, three-ribbed; petals crenate; leaves lance-shaped, alternate; stem commonly solitary, erect; stem nearly two feet high, straight, round, corymbose at the top; flowers erect, with blue-veined petals.*

It is indigenous to several countries in the East, and is generally supposed to have come originally from the alluvial soils of Egypt formed by the overflowings of the Nile.

From the most remote antiquity its fibre has been manufactured into textile fabrics. Several incidental notices in the Scriptures give evidence that it was grown, spun, and woven by the Jews, while Egyptian mummies, embalmed nearly 1200 years B.C., have been found wrapped in swathing-cloths of fine linen. But to follow such traces of the antiquity of this branch of culture, however interesting, would be inappropriate to the present essay; suffice it to say, that, originally a native of the warmer regions of the globe, when introduced in the countries of the temperate zone, the quality of the plant for the finer articles manufactured from its fibre was considerably improved. At the present day it is grown, to a greater or less extent, in all the countries of the north of Europe; in Sicily, Italy, and the coasts of the Mediterranean; to a considerable extent in the peninsula of India; and latterly it has very much increased in Egypt.†

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* Engl. Bot., vol. xix. pl. 1357; Engl. Fl., vol. ii. p. 118.

† The Azores produce a good quality of flax. It has also been tried with some success in New Zealand; and in the high lands of Brazil and Mexico to a small extent.

North America also produces much flax, which, like that of the southern countries of Europe, and India, is principally valued for the seed, although the causes which prevent the economising of the fibre are widely different. To Britain it was brought by the Romans, but was probably known in Ireland at a much earlier period, owing to the intercourse of that country with the Phœnicians.

The experience of late years, since the increase of the linen trade, and the fabrication of the more delicate textures, having caused more attention to be directed to the comparative value of the fibre grown in different countries, has established that, out of the temperate zone, the plant, although it flourishes, and produces a seed superior in many respects to that of cold countries, does not yield a fibre of the same delicacy and elasticity;* in fact, a slow steady growth, from the germinating of the seed to the maturity of the plant, is requisite for the quality and yield of fibre. Hence it is found that, in countries approaching the northern limits of the temperate zone, the short hot summers induce too rapid growth, and, although the quantity of fibre produced is pretty large, it is never of a fine reed. This is strongly exemplified by Russia, as, out of an export frequently reaching 40,000 to 50,000 tons per annum, none sells higher than 48*l.*; whereas in Belgium and Holland the price often reaches 150*l.* and 180*l.* per ton. For the same reason insular countries, or long lines of coast, whose position insures a more equable temperature and a continued supply of moisture from spring till autumn, are found to produce the best flax. In hot climates the character of the plant materially differs from that which it presents in temperate climates. It grows short and branchy, throwing out a large number of seed-vessels, with seeds containing a much larger per centage of oleaginous matter than in the latter, where the plant springs up to a height of 30 or 40 inches in a straight slender stem, with few or no branches, and only two or three seed-vessels to each stalk. Egypt is the only hot country which furnishes any fibre to our markets. Favoured by the rich alluvial soil of the Nile, the plant there attains great luxuriance, but the rule before stated is again recognised, since, notwithstanding the great efforts lately made by the Pacha to improve the culture and preparation, its value has not exceeded 44*l.* per ton.

The quantity of flax consumed in Great Britain and Ireland annually will be learned from the following official list of imports for six years ending 5th January, 1846, extracted from the Returns of the Board of Trade:—

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* Between the parallels of 48° and 55° north latitude will be found the best flax-producing countries of Europe.

	Tons.		Tons.
In 1840. . .	62,649	In 1843. . .	71,857
1841. . .	67,368	1844. . .	79,424
1842. . .	55,113	1845. . .	70,916

Estimating the quantity grown in the British Islands, chiefly the produce of Ireland, as an average of 25,000 tons per annum, and adding it to the above table, we learn that the consumption varies from 80,000 to 105,000 tons per annum. The greater proportion of this flax, after being spun, is woven into linen fabrics of all kinds, from the coarsest canvas to the finest cambric; but a large quantity is exported, in yarn, principally to Germany, France, and Spain. Flax enters into the composition of the following articles: linens of all kinds, lawns, diapers and table-damasks, cambrics and cambric handkerchiefs, the delicate lace textures of Brussels, Malines, and Valenciennes, canvas, drills, sailcloth of all kinds, tapes, sewing and tailor's thread, fishermen's nets and lines, ropes and twine, &c. &c. &c.

But, besides the fibre, a large quantity of the products of this plant is imported in the seed, and oil-cakes manufactured from the seed.

Taking the year 1844, we find the following imports of fibre, seed, and oil-cakes, which will at once give an idea of the extent to which we pay foreigners for the different items of flax produce:—

1,588,494 cwt. of flax at 50*s*. . .	£3,971,200
616,947 quarters of flax-seed at 45*s*.	1,388,131
85,690 tons of oil-cakes at 150*s*.	644,175
	£6,003,506

The flax was furnished by the following countries in the proportions stated:—Russia, 70 per cent.; Prussia, 10 per cent.; Holland, 8 per cent.; Belgium, 7 per cent.; France, 3½ per cent.; Germany, Egypt, Sicily, Italy, and Turkey, 1½ per cent.* The seed from the East Indies, Egypt, Russia, Sicily, Prussia, and Holland. The oil-cakes from France, Germany, and the United States.

With respect to the comparative qualities of native and foreign flax, it is understood that, except for the very finest yarns, the flax-spinners would give the preference to the homegrown fibre.†

* Since that year the quantity from Belgium has increased, and Egypt has furnished a considerable proportion, while a small per centage has been obtained from America.

† The following opinion on the capability of Great Britain and Ireland for producing flax is extracted from the 'Enquête sur l'Industrie Linière de la Belgique' in 1841, through the documents published by the Belgian government:—"Le lin d'Irlande, quand on le tire, est aussi bon que le nôtre, mais les Irlandais sont négligents. Notre lin est mis de suite dans

It has been exported from Ireland to France and Belgium, and for particular grists of yarn, were it generally grown in Great Britain, a considerable export might arise to those countries. The hot summers of Russia and Egypt cause a dryness and brittleness of fibre, and prevent it retaining that elasticity, pliancy, and oiliness which characterise the flaxes of Belgium, Holland and Ireland. Occasional samples of flax grown in Ireland have brought as high prices as the best of Belgian growth; but these have occurred only under the most favourable circumstances as to soil and water, and with the most careful management of the plant. The best samples of British flax that I have seen have brought 65*l.* to 70*l.* per ton. Some was lately grown in Norfolk worth 85*l.*, and some from Bedford sold in Leeds for 100*l.* per ton. The entire quantity of flax required for British manufacture would occupy from 350,000 to 400,000 acres annually. This would furnish the fibre now consumed, but the produce of seed would fall at least 150,000 quarters short of the present consumption for feeding cattle, even after leaving out of account altogether the large quantity of oil-cakes now imported. Taking all these points into consideration, it may be estimated that half a million of acres might fairly be devoted to the flax-crop in Great Britain.

I shall now proceed, *seriatim,* with the details concerning the culture and management of the plant, with reference to its adoption in this country.

Although our climate is peculiarly adapted to the growth of the plant, some localities are more suitable than others. In general, those districts which possess the most equable temperature will be found the most suitable. A regular supply of genial moisture in spring, without an excess of wet in autumn, is most

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l'eau; les Irlandais vont boire et s'enivrer; pendant ce temps le lin peut s'échauffer à l'air. Nos paysans sont soigneux; ils retirent leur lin tantôt au bout de 5 jours et tantôt au bout de 8 jours, suivant l'état du lin; les Irlandais le font quand cela leur plaît. Notre lin est couvert de boue; nous l'étendons sur une belle prairie, et à la première ondée de l'eau il se nettoie: en Irlande on le jette presque au hasard. Les femmes chez nous se chargent souvent des préparations; en Irlande ils se servent de moulins. Nous avons envoyés en Angleterre quelques familles qui sont revenues depuis; mais ces paysans m'ont dit qu'on pourrait avoir du bon lin dans ces pays. Pendant la guerre nous n'exportions pas, la Hollande non plus; les Anglais faisaient cependant d'aussi belles toiles qu'aujourd' hui; alors on récoltait de bons lins dans le Yorkshire, et en Irlande; aujourd'hui ils ont plus négligé la culture. Il faut prendre garde de donner des encouragements." Again,—"Le paysan Irlandais trouve que cette culture le paye; il ne se plaint pas; que serait-ce s'il l'améliorait? Les Anglais cultivent une certaine qualité de lin, mais depuis la paix cela a beaucoup diminué; on peut citer le comté d'York, et principalement les environs de Selby et de Gainsborough."

favourable, and the plant will flourish at a considerable altitude under such circumstances, having been grown with success in county Wicklow, Ireland, at a height of 1060 feet above the sea-level. Our climate is better adapted to flax, in some respects, than that of Belgium, since the severe droughts which frequently occur there in spring often destroy the crop, it being calculated that once in every three or four years it fails from this cause. If, after springing to the height of two or three inches, a long continuance of drought should occur, with a hot sun, the heat parches up the earth, as the delicate leaves of the plant are unable to exclude the scorching rays from the surface-soil, and the roots have not penetrated sufficiently deep to secure a supply of moisture. When the plant acquires a sufficient height to thoroughly cover the ground, dry weather becomes comparatively harmless, but occasional gentle showers are very needful to produce a regular and vigorous growth. Hail-showers, if severe, frequently destroy the young flax. While we possess a superiority over our continental neighbours in the spring, we are not so favoured in summer, as at the near approach to the pulling-time, towards the end of July, the rains often injure the crop greatly, by laying it and causing it to rot on the ground. Flax suffers greatly by lodging, the stems becoming discoloured, when they are not absolutely rotted, and no after-care will eradicate the tinge from the fibre. Hence, fields much sheltered by trees are unsuitable.

This plant will grow on a great range of soils. Sandy loams, light and heavy clays, alluvial soils, marly, peaty, or chalk soils will all produce it well under favourable circumstances. But a mixture of sand and clay is the most suitable, and especially where the subsoil is red or yellow clay. Very light sandy soils will not produce good crops without a large supply of manure, and the root-ends of the flax are generally dry and discoloured. An admixture of peat, if the subsoil be clay, produces good crops. I have known flax grown on an Irish bog, reclaimed three years previous, bring 70*l.* per ton. In this case the subsoil was a gravelly clay. In choosing land for flax, care should be taken that it be deep and easily pulverisable. This infers the absence of water in a stagnant state; but soils which are *very* permeable to moisture, and let it off quickly, are not to be selected. The fibres of the flax-root penetrate from 20 to 30 inches in a straight line downwards, if they meet with no obstruction, and have been known in some cases to go 40 inches deep.

Annexed are two tables, showing the analysis of seven different flax-soils, three Irish and four Belgian. The first table is from the Report of the Flax Improvement Society of Ireland, furnished by Sir Robert Kane.

	Irish, No. 1.	Irish, No. 2.	Irish, No. 3.	Belgian, No. 4.
Silica and siliceous sand	73·72	69·41	64·93	92·78
Oxide of iron	5·51	5·29	5·64	0·66
Alumina	6·65	5·70	8·97	1·11
Basic phosphate of iron	0·06	0·25	0·31	0·21
Carbonate of lime	1·09	0·53	1·67	0·35
Magnesia, alkalies, and sulphuric and muriatic acids	0·32	0·25	0·45	0·12
Organic matter, containing nitrogen	4·86	6·67	9·41	2·74
Water	7·57	11·48	8·62	2·03
	99·78	99·78	100·00	100·00

The Irish soils were from the counties of Londonderry and Tyrone, and were considered very good for flax. The Belgian was from Duffel, in the province of Antwerp, and may be taken as representing a third-rate class of flax-soil in that country, requiring much manure, but producing good crops.

The next table exhibits an analysis by Professor Hodges,* of Belfast, of three flax-soils which I had carefully taken from three districts in Belgium. Nos. 1 and 2 are of the Pays de Waes, the Courtrai giving a flax different in colour from, but of equal quality with, the Lokeren, and both the best, perhaps, in the world; No. 3, the Ypres, a good medium quality of fibre.

Analysis.	Courtrai, No. 1.	Lokeren, No. 2.	Ypres, No. 3.
Water, expelled at 212°	3·80	1·85	2·92
Organic matter, containing nitrogen	4·48	3·25	5·78
Sand and siliceous matter	87·04	91·80	86·47
Peroxide of iron	1·96	1·16	1·57
Alumina	1·52	1·22	1·31
Carbonate of lime	0·96	0·55	0·49
Carbonate of magnesia	0·27	traces	0·51
Sulphates and chlorides soluble in water	0·20	0·14	0·48
	100·23	99·97	99·56

The place which flax should occupy in the rotation of cropping must depend on the nature of the soil. It is not generally considered advisable to repeat flax at shorter intervals than 8, 9, or 10 years.

I annex some instances of the rotations common in flax-growing districts of Ireland and Belgium, the first three being from the former, and the last two from the latter country.

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* For Dr. Hodges's remarks on these soils, see Appendix.

No.	Year 1st,	2nd,	3rd,	4th,	5th,	6th,
1.	Potatoes or turnips.	Wheat.	FLAX, with clover and grass seeds.	Grass-hay.	Grazing.	Grazing.
2.	Oats.	FLAX.	Turnips.	Wheat, with seeds.	Grass-hay.	Grazing.
3.	Turnips or potatoes.	Barley, with seeds.	Grass, cut for soiling.	Grazing.	Half FLAX, half oats.	Turnips or potatoes.
4.	Potatoes.	Wheat.	Rape.	Oats.	FLAX and clover.	Clover-hay.
5.	FLAX, with clover.	Clover, cut for soiling.	Oats, and afterwards turnips.	Potatoes.	Barley or wheat.	Rye, sown with carrots.

No.	7th,	8th,	9th,	10th,	11th,	12th,
1.	Oats.	FLAX.				
2.	Oats.	FLAX.	Turnips.	Barley, with seeds.	Grass-hay.	Grazing.
3.	Barley, with seeds.	Grass, cut for soiling.	Grazing.	Half oats, half FLAX.		
4.	Barley.					
5.						

It may here be observed, that both the Irish and Flemish have been growing flax at much too small intervals of late on the same soil, and in consequence the yield has not been so good either in quantity or quality as when the plant was grown less frequently. In Ireland, flax was formerly sown always after potatoes, but this practice has gradually been giving place to sowing on wheat, oats, or barley stubble, which ensures a much better quality of fibre. The crop is not so luxuriant; but very rank flax never gives a fine fibre, and is apt to be lost, if the weather is showery, when the plant approaches maturity. Flax does not succeed well after turnips. Many persons are in favour of sowing wheat in the year after flax, and I have known instances of good crops being obtained; but this plan will of course be influenced by the nature of the soil. A great advantage in flax culture is, the short time that it occupies the ground; sown in April, it is generally ready for pulling by the end of July.

Hence, a crop of some other kind may generally be taken after the flax is pulled. White carrots are often sown broadcast *with* the flax in Belgium, and the pulling of the flax moulds the young plants, which increase rapidly afterwards, being generally top-dressed with liquid manure. In this country, grass and clover are generally sown along with the flax, so as to give a crop in the following year; but rape, winter vetches, or turnips of the stone or Norfolk globe varieties may be advantageously grown, and used before the following spring.

As a general rule in flax culture, it may be stated, that after any white crop the best produce will be had, except on very poor soils; but in such case the application of manure will give an equally favourable result. The most valuable crops of flax have been obtained from soil which had lain in pasture for a number of years, and, on being broken up, had been planted with potatoes or turnips, followed by grain, and next the flax.

Immediately after the grain is carried the ground should receive a ploughing. The harrow should follow, to clear off roots, weeds, and dirt. The furrows should also be cleared out with the plough, so that they may carry off all rain and surface-water during the winter. In December a second ploughing may be given, and the surface, thus exposed, be left to receive the benefit of the frost. As no crop requires a more thorough pulverisation of the soil than flax, to none is the disintegration of the particles of stiff clay by the expansion, in freezing, of the water they contain, more beneficial. In spring this winter face must be well harrowed, and a roller passed over the ground to consolidate the surface. Care must be taken, in these operations, to lay off the land in broad flats; since, when sown in ridges, the plants grow of different lengths on the tops and in the hollows. After the rolling, a short-toothed or seed harrow follows, to prepare for the seed. This will be a sufficient labouring on most soils, but very heavy clays, especially after a rainy or mild winter, will require an additional ploughing and harrowing about a month before the last. Light soils, again, will do with one ploughing in September and another before sowing, harrowing thoroughly the second time.

In the choice of seed great care is necessary. The Belgians, whom we may take as standards in everything regarding flax culture, prefer the seed imported from Riga which is the growth of the year preceding its export. The seed raised in the following year from this, in Belgium, is considered next in value, while in some districts the preference is even given to it. In Ireland, Riga seed is now almost universally the favourite; but Dutch is considered by some superior for heavy soils. This Dutch seed is also reared from Riga, but is of the second year. The Riga seed, when sown

in England, generally produces the stronger and hardier plant, probably from the amelioration of climate being much more striking than in the case of the Dutch. The former always gives a heavier crop; but the latter produces generally a finer fibre, while, from the greater care with which it is prepared, it is much cheaper than the Riga, which often contains 15 to 20 per cent. of the seeds of weeds, causing a loss to that extent, and being difficult to separate. Seed, the growth of the United States of America, was formerly used to a great extent in Ireland, but has of late got out of favour, since the plant grows branchy, and much fibre is consequently wasted in the scutching. In Norfolk and Essex, seed the produce of the country has been grown, year after year, and goods crops obtained. This practice cannot, however, be recommended, since in Flanders, where the management of the crop approaches perfection, it is never done. Excellent crops have been grown in Ireland from seed saved from Russian, and it is much recommended that enough of the foreign should be purchased by the farmer annually to rear seed for his sowing of the following year, thus keeping up a fresh supply. Where home-saved seed is purchased for sowing, care should be taken to select from a suitable change of soil, the same as with the seed of grain-crops. Riga seed is imported in barrels, containing 3½ bushels, and covered with a coarse linen bag. The barrels are branded in Russia by officers named *brackers*, appointed for the purpose by government, who classify the seed as it arrives from the interior, and arrange it under the terms "sowing seed," "rejected sowing seed," and "crushing seed." Notwithstanding this, however, frauds are frequently practised, by mixing the first quality with the others. Dutch seed is seldom adulterated, and is much more carefully cleaned than Riga. It comes in old wine-hogsheads, which contain 7 bushels each, and are marked with the initials of the shipper.* Each firm becomes thus, to a certain extent, responsible for the quality of the seed which they ship, as those most careful in the selection always command the highest prices. Riga seed varies in price from 25*s.* to 57*s.* 6*d.* per barrel (7*s.* to 16*s.* per bushel), and Dutch from 52*s.* to 95*s.* per hogshead (7*s.* to 13*s.* 6*d.* per bushel). The price is regulated by the demand, or the quantity of each year's crop of a quality fit for sowing. In selecting seed, care must be taken to have it from a respectable dealer, and in Ireland a written guaranty is often demanded that the seed is of the import of the season. Choose

* It may be observed that Dutch seed costs more in these packages than if it were put in bags, by at least 9*d.* per bushel. This arises from a prejudice in favour of the hogsheads in Ireland, to which the principal exports are made, as the farmers have been accustomed to see inferior crushing-seed brought in bags, and consequently prefer the casks.

shining slippery seed, not too plump, and of a brownish red colour. To separate the small weeds from Riga seed, use a wire sieve, 12 bars to the inch. This must be attended to, otherwise great trouble will arise in weeding the crop. It would be well, before making a purchase of seed, to test some samples, by forcing a certain ascertained number of pickles in a hot-bed or dung-pit, and counting the number of sprouts which appear. Very few grains of good seed will miss, while of old or bad seed but a small proportion will germinate.

The quantity of seed to be sown per acre varies from 2 to 3 bushels; the former for poor, the latter for rich soils. About $2\frac{1}{2}$ bushels, or 126 lbs., of clean seed is a fair average. Thin sowing always causes the plant to throw out branches, which yield an abundance of seed, but the fibre is generally coarse; and those portions on the small branches are cut and knocked away in the operation of scutching. Thick sowing, on the contrary, induces the plant to spring upwards in a tall and slender stem, throwing out only one or two little branches at the top, or, more strictly, a mere bifurcation of the stem, of a couple or three inches, supporting two or three seed-capsules. The fibre in this case is fine, but the yield of seed small. Flax should be sown, if the weather be fine, as early in April as possible, or even sooner if the season be mild and favourable. Many persons delay the sowing until May, but the quality of the crop is very inferior to the early sown. For a fine fibre early sowing is indispensable; vegetation is more rapid in the latter part of the season, and the fibre has not time to fine and mellow, the slow steady growth from an early period being necessary for quality. Another advantage in favour of early sowing is, that, in case of the crop failing from bad seed or other cause, the farmer can plough it up, and replace it with some other crop; whereas, with late sowing, he cannot know until an advanced period of the season if the crop will succeed. The seed should be sown by single semicircular casts of the hand, the sower walking down the edge of each flat. Clover and grass seeds, when sown along with flax, should be cast by another person following immediately after the first: this crop is a better nurse for grass and clover than any of the cereals; but, by preventing the circulation of air about the roots of the flax, they frequently cause the moisture to discolour them, and thus reduce the value of the fibre. Cover, after sowing, with a light seed-harrow, the teeth thickly set and short: if the weather be showery a single turn will be sufficient; but, if dry, two are advisable. Finish with rolling, unless the ground be so wet as to adhere in clods to the roller.

Throughout Belgium and Holland it is the almost universal practice to manure the land for flax. Horse or cow dung, wood-

ashes, lime, and night-soil are used; the last is much esteemed. But the favourite manure is *tourteaux* (oil-cakes) of rape, cameline, and poppy, sometimes applied dry, but more frequently dissolved in urine, at the rate of 100 cakes to the *cent* of land, the quantity of urine being about 2400 gallons per acre. This manure warms and forces forward the young plant better than any other; and many farmers maintain that it conduces to fineness of fibre. Some apply farm-yard manure at the first ploughing in November, and the *tourteaux* in March, about eight to twelve days before the sowing. In Ireland the farmers seldom, if ever, apply manure, considering the ground sufficiently enriched by the manure applied with the green crops two years previous, and fearing rankness of growth and consequent injury of the crop by lodging in the summer rains.* When the young flax-plants have attained the height of a couple or three inches they should be carefully weeded. So much stress is laid on this point, both in Belgium and Holland, that they are sometimes weeded twice, or even three times, at intervals. The chief reason is, of course, to prevent useless vegetation abstracting a portion of the nourishment; but weeds are hurtful, also, to the flax-crop, in retaining moisture, and preventing the circulation of air; this invariably causes a discoloration about the root-ends. The operation of weeding should be very carefully done, so as not to injure the tender young plants, by women or children, who, after wrapping cloths about their knees, should commence, in a creeping posture, to weed the field, turning their faces always to the wind. By these precautions the plant is not crushed into the earth, as it would be by the weight of persons walking over it; and, being all pressed one way, facing the wind, is raised by the current of air to its upright position in a short time. A breezy dry day will therefore be most appropriate. Flax is in the most critical period before it covers the ground sufficiently to keep off the rays of the sun from the soil; hot dry weather, coming on before this, parches up the roots, and their delicate fibres are withered, the plant droops, turns a whitish-yellow, and, if the drought continues long, dies altogether on arid tracts of ground. In such a case I have known flax to be watered with a regular water-cart, which will go over an acre in the day, and much good to result from the application.

During the latter end of June flax flowers; at which time the plant, with its delicate blue blossoms, presents a beautiful appearance. After the flower drops off, the seed-capsules, or bolls, begin to form; when they have attained their full-size, about the

* Guano has been applied without benefit to flax. Among Liebig's patent manures is one for this crop.

middle of July, they are nearly globular, consisting of cells ending in a point; each boll contains about seven to ten pickles of seed, which consist at first of a whitish film, enclosing a watery pulp; by degrees this becomes solid, and the seed changes in colour to a pale-green. When this occurs it will be necessary to examine the seeds daily, as their state is one of the best criterions of the state of readiness for pulling of the crops. The Dutch mode of ascertaining this is as follows:—a full-grown stem is selected, and the ripest capsule is cut horizontally with a sharp knife; if the interior of the seed-pickles is then found to be firm, and of a dark-green, the flax is considered fit for pulling. The entire plant will be observed to show signs of maturity; the stalk close to the ground has assumed a yellow colour and hardened considerably, denoting the contraction of the vessels through which the sap was conveyed. If allowed to stand some days longer, the colour will be seen to change by degrees up the stem, until it reaches the bolls, all the sap having then reached the seeds and perfected them. Soon after this the plant sheds its seed and dies; but it must be pulled at the earlier stage before noted, to secure the perfection of the fibre, since, after the juices of the stem have been exhausted, the flax becomes coarser, drier, and of a much inferior quality; whereas, by pulling earlier, it is found silky and elastic. Long experience has shown early pulling to be the most profitable; for, although the seeds have not become fully matured, yet, if dried slowly, they will absorb from their integument a sufficiency of sap to render them of a certain degree of ripeness, although, of course, not so plump as in the other method.

If the flax be of different lengths, owing to a mixture of seed or inequalities in the land, each length should be pulled up separately. This can be effected by the pullers catching the stems just underneath the seed-bolls, which allows the shorter stalks to escape, and they can be taken at a second pulling. These two lengths must be kept separate in all the subsequent operations; the reason for this is because a great waste occurs when both are pulled and steeped together, as the shorter stems continually fall out of the bundles; and when the flax is scutched they are knocked away and lost among the refuse and tow. The handfuls of flax, as pulled, should be laid separately on the ground, taking care that the butt-ends be struck against it two or three times to keep them even.

Three courses for the future treatment of the plant are now open for choice:—

1st. The flax may be rippled immediately after pulling, and steeped at once.

2nd. It may be dried in stooks of a peculiar construction, the seed beaten off, and the stems steeped shortly afterwards.

3rd. It may be dried as above, stored past, the seed beaten off during the winter, and the flax steeped in the following summer.

The first plan is that most generally practised where flax is grown in the British islands, in Holland, and most parts of Belgium. After the flax has been pulled, as before described, it is *rippled.* Rippling is the term used to denote the separation of the seed-bolls from the stems by drawing them briskly through a machine (*fig.* 1), composed of a row of iron teeth, about 18 inches long, half an inch square, a quarter of an inch apart from each other at the bottom, and tapering slightly so as to be half an inch asunder at the tops, which are sharpened. These teeth are screwed into a flat piece of wood,* which can be bolted down to a bench or plank set on upright supports about 8 or 9 feet long, on which the operators sit astride, facing each other. A winnowing-sheet is spread underneath to receive the bolls; the flax, as pulled, is laid in handfuls, crossing each other diagonally, at the right hand of each rippler. He takes up a handful, and, grasping it with one hand, with the other he spreads out the top, so as to present a broad fan-like surface to the ripple. If the seed-bolls are numerous, as in branchy flax, the points, merely, of the stalks should be first drawn through the ripple, and then the remaining part bearing bolls. Where the stems, as is generally the case with fine flax, bear only one or two bolls each, once drawing through will suffice to take them off. Indeed, it is better, in all cases, to lose a small proportion of bolls by allowing them to remain on the stems, than by drawing them too frequently through to risk the tearing or fraying of the fibre in its soft state. Careless ripplers neglect spreading the points sufficiently; and the force of the pull, which should always be smartly done, drags out whole stalks, breaking others, and doing much injury; hence has arisen a prejudice against this operation in many parts of Ireland, where the value of the seed is not sufficiently understood. The ripplers strike the flax through alternately; and, when well practised, four men, with two rippling-combs, will take the seed off rather more than an acre in the day. Flax is much easier to handle after rippling, as the interlocking of the bolls makes it very difficult to separate the handfuls and keep the flax even. The ripplers lay down each

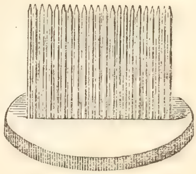

Fig. 1.

* Some persons prefer having these pins screwed into a cast metal frame, as they do not then twist or warp.

handful at their left side, and they are tied up in sheaves, and immediately taken to the steep-pool.

The bolls are riddled, to separate the long stalks that may be among them, and are put through fanners to blow off the leaves. If the weather be dry, they should be spread on winnow-cloths, in an airy part of the field, and turned twice or thrice a-day. In this way they will soon dry thoroughly, and no more care will be necessary than to stow them away in bags, or heap them on a boarded floor. If the weather be showery, they should be thrown into a heap before the heavy rain and covered with boards, and, when it is again fair, spread out as before. But if the rain be too continued to admit of this, they must be removed to a large loft, where, by opening all the windows and doors, a thorough current of air can be produced. By making them into long narrow heaps, precisely resembling drills, and turning them twice a-day, constantly presenting a new surface to the air, they dry slowly and well. When nearly dry, they may be removed to a corn-kiln, and by a gentle heat they will be thoroughly finished, so as to keep any length of time without fermenting. Care must be taken to spread a winnow-cloth on the tiles, as otherwise the cracking of the bolls may allow some seeds to fall through, and, besides the loss, cause a danger, by their ignition, of burning the whole. The heat must not be above 60 or 70 degrees.

On the second system named above, the flax, when pulled, is set up in long narrow stooks, the tops of the stems resting against each other, in this form Λ. The labourer sets them up by taking a portion of flax in each hand, stretching out his leg, and resting the butts of the flax on the ground, making the tops meet above his knee. Fresh handfuls are reached to him, which he sets up in the same manner, moving slowly backwards, the bolls interlacing and assisting to keep the stems upright. He thus forms the stook, retreating step by step, and adding the handfuls of flax in a continuous line, until he has made it 6 or 8 feet long. The seeds, thus exposed to the action of the atmosphere and sun, soon mature, the stems becoming of a golden yellow colour, and all the sap being absorbed. A week or eight days is generally sufficient for this, but the time varies according to the state of the weather. The flax may then be put up in sheaves in the field, in a stack formed by sticking poles into the ground in the shape of a parallelogram, and packing the flax-sheaves, butts and tops alternately, in this frame, to the height of 5 or 6 feet, thatching lightly with straw, and placing brambles at the bottom to keep the flax from the

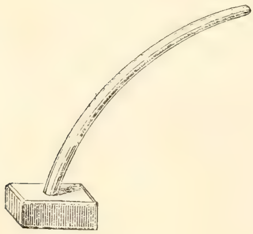

Fig. 2.

ground and admit the air. This mode of drying is generally requisite, but in very dry weather may be dispensed with, the former plan sufficing, and the seed may then be taken off, and the flax steeped. The seed may be thrashed out, or beaten out with a tool made for the purpose (*Fig.* 2, p. 376).

On the third system the same plan of drying is adopted, but, instead of steeping the flax in the same season, it is stacked past until the following year. The seed is taken off at leisure during the winter. The most usual mode, in Belgium, of separating the seed, is to spread two rows thinly on a barn floor, the tops meeting in the centre, and two labourers walk along the flax, facing each other, and giving the tops repeated blows, alternately, with the simple wooden instrument formed for the purpose, *fig.* 2. By this means all the seed is beaten off without any injury to the fibre of the top-ends, which would be risked by rippling it in this dried state. I have seen the seed taken off here by a thrashing-machine, a bit of wood being inserted between the rollers to keep them open, and the points of the flax inserted, when the beaters knock off the seed. This mode, however, is not so safe, though much more expeditious.

To resume the operations, after pulling, with flax on the first method, which is that which will be generally practised in this country. The first is the steeping process.

The stem of flax consists of three parts, the inner part, *shove*, or wood—the pure fibre—and the gum-resin, which causes the fibres to adhere together. Until the latter be completely separated, the fibre cannot be obtained in a state fit for manufacture. Mechanical means are quite inadequate for the purpose, as the union is too intricate. Chemical decomposition is, therefore, the only way in which this end can be accomplished. Various modes of effecting this decomposition have been tried. The use of diluted sulphuric acid, of solutions of caustic-potash and soda, of a strong ley of black soap, of lime, having all been tried, are liable to grave objections, which oblige us to set them aside. The action of water, at a certain temperature, seems as yet the only effectual means of freeing the fibre from this gum, and preserving its integrity. There are three modes by which this has been done:—

1st. The spreading of flax upon the grass, exposed, for several weeks, to the action of the atmosphere, dews, and rains.

2nd. The steeping in slow currents of water.

3rd. The steeping in pools or pits filled with water.

The first of these is practised in the Walloon country and in the United States of America. It is a tedious mode and attended with many disadvantages. It may, however, be adopted when there is little water to be had for steeping, or when the water is of bad quality. In Hainault, four weeks are considered sufficient for

this process, but the time will depend greatly on the temperature of the air and the quantity of rain that falls. Linen made from flax thus wetted requires a shorter time to bleach, as the colour is already partly extracted from the fibre.

The second plan is practised to a very great extent in localities of Belgium and France, through which the river Lys flows. This stream is very sluggish and deep. It rises in the north of France and flows through West Flanders. Such is the celebrity of its water for steeping flax, that the latter is drawn from great distances to its banks, and even brought from Holland and France to be steeped; and the steeping, which is carried on as a regular trade, affords employment from April to September to great numbers of people. A vast quantity of flax, saved on the drying system described before, is steeped about Courtrai; and hence this method of managing flax is often termed the Courtrai system. The flax is packed in crates, made of round wooden staves, 10 to 14 feet long, 8 or 9 wide, and 3 deep. The sheaves are put in perpendicularly, or should be, but latterly, in consequence of the great increase in quantity of flax sent for steeping in the Lys, economy of space has become an object, and they are pressed tightly in horizontally, although this does not allow so fine and even wetting. The crates thus filled are sunk in the stream, being kept a few inches under the surface by large stones.

The great repute of this water for steeping flax induced me to have a small quantity of it analysed. I accordingly procured in the month of November a stone bottle full, from the middle of the stream, in a part where much flax is steeped in summer. It was submitted to Professor Hodges for analysis, and the following is the result:—

A gallon contained—

Inorganic matters . . .	19·67
Organic matters . . .	2·86
	22·53

The inorganic matters consisted of

Chloride of sodium . .	1·90
Sulphate of lime . . .	1·22
Carbonate of lime . .	13·58
Carbonate of magnesia . .	1·27
Oxide of iron . . .	1·13
Siliceous matter . . .	0·80

The steeping of flax in running streams cannot be made generally available in Great Britain, as most of them are too rapid.*

* In Ireland a clause in the fishery laws prohibits the steeping of flax in rivers or streams, as it renders the water poisonous to fish, vast numbers having been killed in the steeping season.

It will therefore be necessary, in almost all cases, to have recourse to the third method, viz. steeping in pools or pits filled with water.

In selecting a site for a steep-pool there are many points to be taken into consideration. The first, of course, will be its position with respect to a supply of good water. Water fit for steeping flax should be perfectly free from any ferruginous particles; after it has flowed over soil containing any metallic deposit, soluble in water, it is quite unfitted for steeping flax, as it invariably discolours the fibre, and the stain cannot be effectually removed by bleaching. Again, what contains carbonate of lime in quantity, or, as it is familiarly termed, *hard* water, and spring water in general, are unsuitable. The best description of water is such as has flowed for some distance exposed to the action of the air, which mellows it, and allows the impurities to subside. The pool should, therefore, be so placed that water can be admitted into it from a river, brook, or small stream. As flax is improved by a very gentle current flowing over it while in steep, so as merely to carry off the scum which rises to the surface, it is advisable to try to make this available by a careful regulation of the source of supply. Water which has flowed over peat, or has lain on peaty soil for some time, is very good for rotting flax, the antiseptic properties of the peat correcting the usual defects of stagnant water—that is, provided no bog fir-resin exists in it, which is injurious. A pool 38 feet long, $3\frac{1}{2}$ to 4 feet deep, and 10 feet broad, will contain the produce of an acre of flax. The description of soil forming the bottom of the pit influences the colour of the fibre. A clay bottom gives a yellowish-white tinge, alluvial soil a bluish shade, while peat often gives a very pure white. If no river or other running water be available, and spring water must be used, it should be let into the pit six weeks before the flax is put in; it will then have time to fine and soften by the action of the air and sun, and the deposition of any calcareous sediment. Running water need not be let into the pit until a day or two previous to the steeping. It is advisable to cut a small drain, at the distance of a few feet from the pool on every side, and about 6 or 8 inches deeper than it, to intercept any water which might filter from the soil into the pool, and prove injurious to the flax.

The flax, after rippling, should be immediately placed in the steep-pool; the sheaves are packed loosely, resting on their butt ends, and a little sloped. It is considered best to put but one layer in the pool, though two are often packed, for the convenience of retting a larger quantity at a time. When a plentiful supply of the best water is at hand, many persons pack the flax in the pit before letting in the water; the only advantage in this is, that it enables the workers to place the flax more regularly. If the crop

has grown of uneven lengths, each length, as before remarked, should be kept separate, and steeped in a different pool, or a different part of the same pool. The flax must be covered from the light by sods, with the grassy side underneath, or long wheaten straw, kept down with stones or heavy logs of wood. The object is to keep the flax entirely under the water, and yet not resting on the bottom of the pool. When it begins to ferment, or "take with the water," the latter becomes turbid and discoloured, and gas is evolved with an unpleasant odour. This, although disagreeable, is quite innoxious, and the Belgians even say that during the ravages of the cholera the steeping districts suffered least. The water poisons fish; but in small quantities, or much diluted, it cannot injure cattle, since they are often allowed to drink in the Lys, at a time when it is filled with flax for miles in extent. Alder-leaves are sometimes put in the flax-pools in Holland, to give the flax a bluish tinge; the Flemish frequently cover the flax with the mud of the pits, which also gives a blue colour.

When the decomposition is general, some additional weights must be placed on the flax as it rises and swells in the water; a thick scum appears on the surface, containing the grosser particles of the gummy matter, and this should, if practicable, be gently floated away by a slight stream trickling over the pool.

The time necessary for flax to remain in steep, so as thoroughly to separate the fibres from the gum, and to arrest the putrefactive fermentation before it injures their strength, is entirely dependent on the nature of the flax, the state of the atmosphere, and the quality of the water. Six days is the minimum, twenty the maximum for this effect. In sultry weather, especially if there be occasional gentle rains, with a humid atmosphere, the decomposition is rapid, and is greatly retarded by cold nights.* Fine flax is more easily watered than coarse. When ready to take out it will be observed to sink in the pool, but it requires a much more careful examination from time to time. The test in Holland is as follows:—A few stalks of average fineness are selected, and are broken in two places a few inches apart; if the inner part or wood will then pull easily out with the fingers, and does not break the fibre or drag any of it with it, the flax is considered sufficiently watered; if allowed to remain longer, the fibre is injured, and becomes weak and cottony; if taken out sooner than

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* A patent has been taken out by an American for steeping flax in water placed in wooden vats, with false bottoms, which are perforated with holes. Underneath is placed a coil of pipes, into which steam is introduced, and the water heated. A medium temperature of 90° is maintained, and the flax is sufficiently steeped in 50 to 70 hours. This advantage arises from the avoidance of alterations in the temperature of the water.

this test shows to be advisable, much of the fibre is knocked away in the scutching, and the general quality is dry and coarse. The test should be tried at intervals of three or four hours after the fermentation ceases, for, if the weather be warm, the change for the worse is rapid. When several trials have shown that the flax is sufficiently watered, it should be very carefully removed from the pool. The weights and covering of straw should first be lifted off, and the latter taken to the dung pit, as, being saturated with the water, it makes valuable manure. Flax in no state suffers more injury from careless handling than when newly taken from the pool. A person should stand in the water, lifting out the bundles to the bank, and in no case should he use a pitchfork or hook; others on the bank receive the bundles and set them up on their butt ends, by which means the water is permitted to gradually soak away, and the root ends have the longest maceration, which makes up for their position at the bottom of the pool, where the temperature of the water is not so high as at the top, and they are consequently left a little hard. The fibre becomes firmer than if the flax were immediately spread. Care must be taken that it be not too closely packed, or it may heat and spoil. If much rain should fall while the flax is being taken from the pool, it must not be spread for 36 hours, but in fair weather it may be spread 24 hours after taking out. If very dry, a light covering is useful, to prevent the sun from hardening the tops.

For spread-ground the closest and shortest pasture is preferable, with all inequalities of surface, caused by weeds, removed by cutting them. A grass field, newly mown, will also suit, and the matters washed away from the flax by rain or dew give the grass a good top-dressing. The object of grassing flax is thoroughly to cleanse the fibre, and to improve its colour by exposure. It must be thinly and evenly spread, a tape line being useful to guide the roots of the first row, and a small space may be left between each of the following rows. To insure a uniformity of colour, turning the flax is necessary; this is done with wooden poles, about 2 inches in diameter at the butt, tapering to the size of a walking-stick at the top, and 8 or 9 feet long. Two turnings will be sufficient, and they should be done just before showers, the rain settling the stalks on the ground and preventing them being blown about by the wind. Three to five days will be sufficient for grassing, if the weather be fair and the flax fully steeped; if the flax is a little hard, a day or two longer will improve it. The best test of its readiness for lifting is, to try a few handfuls with the scutching implements. When the fibre is thoroughly dried, it will be seen to separate from the woody matter, and to contract, causing an appearance familiarly termed "the bow and string." When this is observed to be general the

flax is quite ready to lift; when lifted, it should be neatly tied up in sheaves and packed under cover, or neatly stacked and thatched in the rick-yard. In this way it will keep well for years, and it is understood that the quality of the fibre improves up to the third or fourth year after steeping.

The flax is now ready to undergo the final operations which fit it for the market. The object now is to separate entirely the fibre from the wood with the least possible injury and loss; this may either be done by manual labour or by machinery, and the preference is to be given to one or other according to circumstances. It is by manual labour that nearly all the flax in Russia, Holland, and Belgium is dressed, and it employs a vast number of persons; in Ireland a considerable quantity is also prepared in this way, but the greater proportion is scutched by machinery. In the case of a small farmer, or cottier, or where it is an object to employ the labourer or the weaker hands, scutching by manual labour is preferable; but to the large farmer, with a considerable crop and few labourers, it is tedious and expensive, and machinery is much to be preferred.

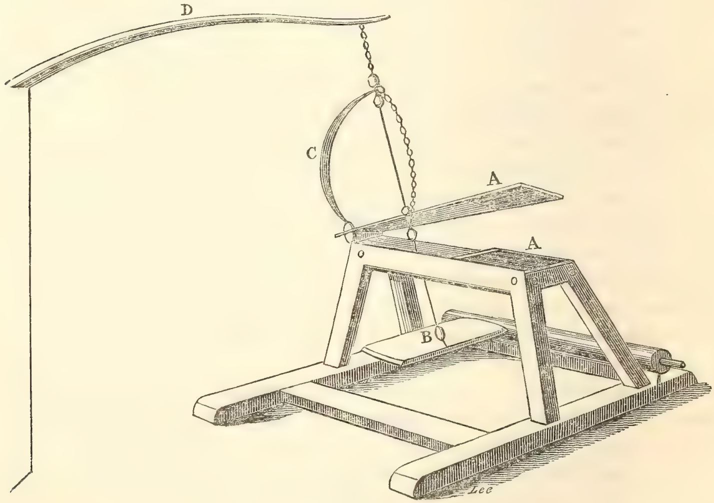


Fig. 3.

The flax prepared by hand is first bruised in a machine (*fig.* 3) where two small rows of iron grooves (A A) meet on the flax which is placed between them: so that each convex part of the upper row falls into the concave part of the under one, and bruises the wood without injuring or cutting the fibre. This is worked by the foot pressing upon a flat moveable piece of wood (B), which is attached by a chain or string to an iron spring (C)

fixed at the extremity of the machine; or a spring-pole (D) will answer the same purpose and give more power. The operator introduces the top-ends of the flax, and gradually slips it through, bringing down the upper row of grooves quickly upon it until it is sufficiently bruised, when a person at the opposite side of the machine takes the handful out. A hard wooden mallet (*marteau*) and a flat stone or block of hard wood are used to bruise the flax in many parts of Belgium; but this is a more tedious mode than the other. After being thus bruised, the woody part of the stem will part freely from the fibre in the operation of scutching, leaving it in reeds. This is effected with a broad flat blade of wood, about a third of an inch thick (*fig.* 4) and generally made of bay-wood, black birch, or sycamore. The operator holds this

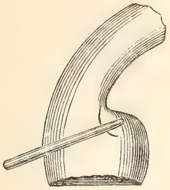


Fig. 4.

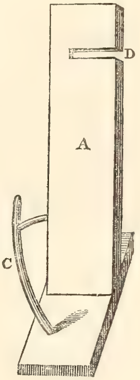


Fig. 5.

in the right hand, and with the left introduces a handful of the bruised flax-stems into the groove B of the stand A (*fig.* 5); and by repeated blows of the scutch-blade, turning the flax frequently to present fresh surfaces, and regulating the power of the stroke to the nature of the flax, strikes away the bruised bits of woody matter; a buff-leather belt is stretched between the stand and an upright stake (C), which is inserted in the flat bottom; and after the blade strikes the flax it falls on and rebounds from the leather, which saves much fatigue to the worker. Any remaining bits of shove are scraped away with a broad blunt knife (*fig.* 6), the flax being laid across the worker's leg, which is covered with a piece of leather, and scraped in that position. An expert scutcher can turn out from 8 lbs. to 14 lbs. of clean flax in the day, but the quantity will depend on the quality: as, of hard, coarse, badly-watered flax, not more than one-half or one third this quantity could be done in the same time.

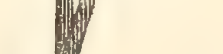
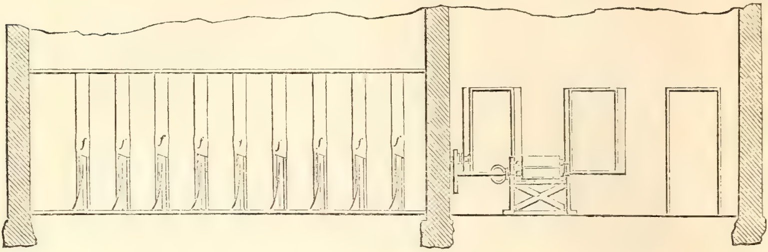
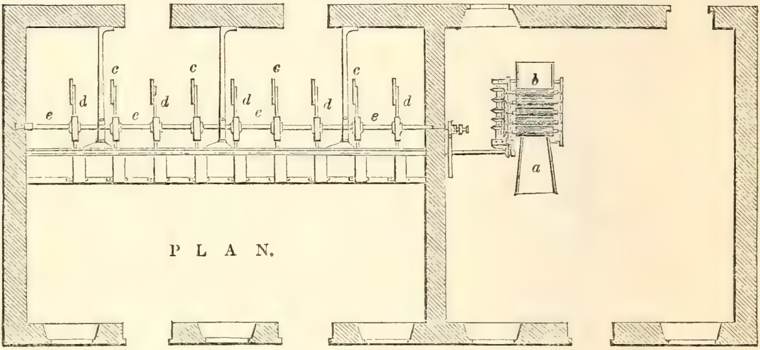


Fig. 6.

Plan and Elevation of the Improved Flax-rolling and Scutching Machinery, as manufactured by Messrs. MacAdam Brothers and Co., Engineers, Belfast.

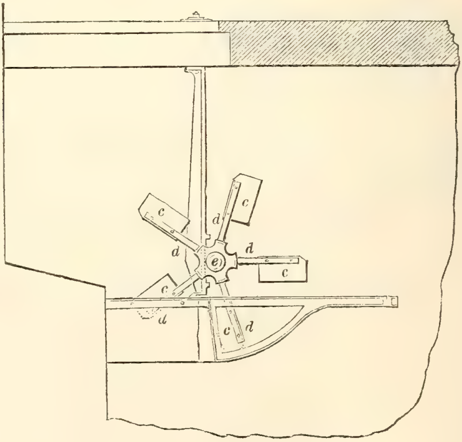
FRONT ELEVATION.





PLAN.

END ELEVATION.



The process by machinery is conducted on the same principle as by hand-labour. The breaking or bruising of the flax-straw is effected by metal groved-rollers, four pair being necessary, fluted in different breadths. The flax is spread on a flat table (*a*), just as grain in a threshing-machine; the first pair of rollers taking it in and passing it on to the others in succession, until it issues from the last pair (*b*) completely bruised. This is an improved system of breaking, as it was formerly done in Ireland and Scotland by three wooden vertical rollers, and the flax had to be frequently passed through; while the operation was attended with great danger to the labourer, many accidents occurring by his arm being caught in the rollers. The action of the scutch-blade is adopted in machinery by a number of blades of wood or iron, (*c*) attached to arms (*d*) like the radii of a circle, and carried round by a shaft (*e*) which is turned by the motive power; the flax is held by workers in a groove (*f*) similar to that in the hand-scutching mode, and the blades in their revolution strike it quickly. The stands are so cased in that the person is in no danger: a plate of iron protecting his hand above and another underneath the strick of flax. He has only to hold the flax until he sees that it has been sufficiently struck, and then to present the other end, turning it frequently that the blade may act equally on all parts. Mills are generally made with 6, 9, or 12 stands. It is considered best to divide the labour of cleaning each strick of flax among three different stands; a long table runs in front of them, and a handful of flax, as bruised by the rollers, is laid on it. The first man, or *buffer*, takes it up, presents it to the blades, and lets it have a number of strokes at both ends and sides; he then lays down on the table, when it is taken up by the second man, or *middler*, who puts it through the same process with his stand, handing it to the third, or *finisher*, who cleans it thoroughly in the same way. The flax, when finished, is tied up in bundles of 16 lbs. or 24 lbs., the former termed the English and the latter the Scotch stone. Each bundle consists of a number of handfuls of flax, about 1 lb. weight in each, which are stretched straightly and evenly on the table, a slight twist being given each to prevent it mixing with the rest. It is tied round with three or four bands of flax twisted tightly, and, if well made up, may be tossed about without receiving any injury. The power to drive the machinery may be either horses, water, or steam. In the north of Ireland, of late, much flax has been scutched by steam, as the woody refuse of the stem supplies fuel without any other being necessary. The refuse, on being knocked off by the blades, falls into a pit behind the stands, and is cleared away during meal hours.*

* The refuse of four days' work will drive the engine six days.

The cost of the machinery of a mill, consisting of the rollers and 12 stands, is about 120*l.* to 140*l.* exclusive of buildings and motive power. A smaller set of rollers to break for 3 stands can be made, but are not so efficient. All the casings of these mills should be made of sheet-iron, which greatly diminishes the risk from burning; and the handles or scutch-blades should also be constructed of thin plates of iron, which are quite as efficient as wood and do not require renewal.

The comparative merits of the two modes of scutching flax must be judged of with relation to the peculiar circumstances of the district in which flax is cultivated. Where labour is superabundant, and it is an object to afford productive employment in order to avoid the claims that would otherwise arise for parochial support, hand-scutching is decidedly the most suitable. The comparative amount of employment afforded by each system may be learned from the following calculation:—A mill with 12 stands will break and scutch 80 stones (16 lbs. each) of flax per diem, giving employment to 12 persons scutching and 2 breaking, at 2*s.* 6*d.* each, in all 1*l.* 15*s.*

The same quantity of flax scutched in the same time, by hand, would require (taking 8 lbs. as the average out-turn of flax from each individual) 160 persons, earning one penny per lb., which is, in all, 5*l.* 6*s.* 8*d.*

One shilling per stone is the usual charge in the mills: but the additional fourpence for hand-work is usually made up by a larger yield of clean fibre, especially from fine flax; since the labourer can regulate his stroke to the strength of the flax, while, with machinery, it is impossible to save it beyond a certain point, and much of the fibre is often broken away, selling only as "scutching tow," at about a tenth of the value of clean flax. Women and young lads can work as well at hand-scutching as men; and the farmer can arrange the period for dressing his flax according to the time when he has least work of other descriptions for those dependent on him. To the cottier this system is obviously the best, since it enables him to prepare his flax at leisure, by means of the productive labour of himself and the members of his family at periods when they have no other occupation. In Belgium the winter is chosen to dress flax, and the people work at it early and late; many persons in England pay more than one penny per lb.; but it is not right to take a higher basis in comparing the merits of the hand and machine systems.*

When labour is comparatively scarce and the farms large,

* The farmers and flax dealers in Flanders pay eight to ten sous per diem, and food, to their labourers employed in scutching flax.

hand-dressing flax is much too tedious and the mill must be preferred. Where water-power or steam is made available for thrashing or other farm purposes, machinery for scutching flax can readily be attached. Some practice is necessary to make an adept at scutching in the mill, but men can easily be had from the north of Ireland to teach the system. The work, as in all other cases, will, of course, be best executed when it is taken up by some person as a trade, and at the rates paid for scutching it is understood to be a lucrative business.

Flax, after being scutched and made into bundles, should be stored on a ground-floor, in a cool situation, but no damp should be allowed to penetrate it. It keeps better thus than in lofts or airy situations, where it gets dry and brittle and does not look so well. It is to be observed, also, that it never looks so well when just scutched, as after it has lain for a few weeks in the store.

The great markets for flax to supply the spinning-trade of the three kingdoms are respectively Leeds, Belfast, and Dundee. There are commission-merchants in each, to whom flax may be sent for sale, and through whose hands large quantities of the article pass; the spinners also purchase individually. In all the districts in Ireland, where flax is much grown, markets are held on appointed days, at which agents attend to purchase flax; the farmers bring it in carts, and in a short time all is cleared away.* This method, however, entails expense on the purchaser, and of course lessens the farmer's profit. Much of the flax is also bought by jobbers, who resell it to the spinners and make profit by it. In all cases, if possible, no party should come between the producer and the consumer, except the agent through whom the latter purchases, and whose commission is generally very trifling. The finest yarns are made by the English spinners, with a small proportion of medium and coarse. Ireland manufactures the great bulk of the medium numbers, with some fine and some coarse. Scotland produces generally the very coarsest, though some fine also in particular localities. This information is of use to the flax-grower, as, if his flax be fine, Leeds will be his best market, while Belfast and Dundee will be better for the medium and coarse.

Before taking up the remaining subjects of this section of the essay I would revert to one or two points in explanation of some of the processes.

The system of treating flax described under the third head, or that commonly termed the Courtrai method, has its advantages. It gives seed much preferable for sowing to the rippling system,

* 10,000*l.* worth of flax has thus been purchased in one day in a small market town.

and it enables the farmer to store past his crop at a busy period of the year, until a leisure time in the next spring, and does not bind him down to any precise time for steeping, since he can choose any time from May till September for that operation. Flax thus treated requires a longer time to water than what is steeped green, and is rarely of so good a colour or quality in this country, although in Belgium it is equal to any, and superior for some purposes. This, however, may be owing to the peculiar excellence of the Lys water for steeping, all dried in this way being so retted. There is a mode of growing flax practised in the neighbourhood of Cambrai which deserves a brief notice. Double the usual quantity of seed is sown, and small sticks are set up in the ground with branches of shrubs or brambles resting on them a few inches from the surface. The plants push up through this covering and are so supported by it that they cannot afterwards be blown down by wind or rain, however violent. The greatest care is given to the manipulation of the crop in every stage, and after it has been carefully scutched the fibre brings a very high price for the manufacture of lace thread. This system is of course only suited to the small cottier who can devote close attention to its management.

After the flax has been taken from the pool means should be taken to make available for manure the water which it contains, which holds dissolved nine-tenths of the organic matters that the plant takes up from the soil. Its analysis is thus given by Sir Robert Kane. It was evaporated to an extract, and yielded, dried at 212 degrees—

Carbon	30·69
Hydrogen	4·24
Nitrogen	2·24
Oxygen	20·80
Ashes	42·01
	100·00

The large proportion of ashes was next analysed, and gave the following result, in 100 parts :—

Potash	9·78
Soda	9·82
Lime	12·33
Magnesia	7·79
Alumina	6·08
Silica	21·35
Phosphoric acid	10·84
Chlorine	2·41
Carbonic acid	16·95
Sulphuric acid	2·65
	100·00

Sir R. Kane reasoned from this analysis that "restored to the soil the steep-water should give back all that the crop of flax has taken from the soil, and thus the valuable fibre being generated by the atmosphere, the great source of expense in the cultivation of the plant will be removed." The quantity of nitrogen, phosphoric acid, potash, magnesia, and lime taken up by the flax-plant from the ground renders it a highly exhausting crop; but if the above analysis be correct, the conclusion may be safely drawn that as the great mass of these substances is found in the steep-water, with a portion also in the woody part of the stem, and as the pure fibre is generated at the expense of the atmosphere alone, if the refuse parts of the plant be returned to the soil, the exhausting effects of the crop are of course completely neutralised. This analysis excited much attention in the flax-growing districts of Ireland, and was received with considerable incredulity. Trials of the efficacy of the flax-water as manure have, however, been since made by several individuals in all cases with successful results.*

Different modes of rendering the steep-water available, without much cost in carrying and applying it, have been suggested. When the flax-pool is situated on an acclivity it can be ladled into troughs, and carried by irrigation over grass lands; or the steep-pool may be filled up with weeds, chaff, or refuse of any kind that will absorb the water, and more added from time to time, until the whole becomes a fermented mass of sufficient consistency to carry in waggon-loads to the fields. Watering-carts used for liquid manure, with a perforated pipe to diffuse the water, will also answer the purpose. The water should be applied soon after the flax has been removed from the pool, as it loses much of its value by exposure to the atmosphere, giving off gaseous matters and depositing a sediment. The pool, when cleared out, should be paved so as to preserve it from impurities until the

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* The subjoined experiments were made at Market-hill, county Armagh. An acre of two-year old lea was flooded with flax-water, and in the season after the produce of oats was double that obtained for fifteen years.

A two-acre field was divided, and one half dressed with 20 barrels of lime, the other half with flax-water. The latter gave the best crop by 30*s*., and the additional cost of the lime on the other was 30*s*., which made a difference of 3*l*. on the profit of the acre.

Another person applied the water to part of a field of potatoes, which gave nearly double the produce of the undressed part. A crop of flax afterwards grown on the same field showed a remarkable difference on the two portions: applied to oats, the portion dressed gave 128 stones; an equal portion, undressed, 96 stones.

In another case, flax grown on land where the same crop had been grown three years previous, and thus watered, produced a better crop than another portion of the same kind of soil and on the same farm, in which flax had not been grown for fourteen years.

following season, or if it has been made shallow with sloping banks may be sown with grass seeds.

The other refuse part of the plant, viz. the shove or woody portion of the stem, is of but slight value as manure. Sir R. Kane gives its composition as follows:—

Carbon	50·34
Hydrogen	7·33
Nitrogen	24
Oxygen	40·52
Ashes	1·57
	100·00

It is therefore only the thirtieth part as valuable, weight for weight, as the dried steep-water extract. It is with difficulty decomposable under ordinary circumstances, or even when mixed with highly fermenting manure. It may be advantageously used for absorbing the steep-water, or may be mixed in the dung-pit. When used as fuel the ashes should be carefully preserved.

Since this analysis was made, Professors Johnson and Hodges severally investigated the subject, and published, as the result of their labours, that every 100 lbs. of flax fibre contained, on an average, 2 lbs. of mineral matters, including lime, magnesia, oxide of iron, carbonic, phosphoric, and sulphuric acids, and silica. This very small proportion showed Sir R. Kane's deductions to be practically, if not literally, correct.

The following table will give a general idea of the weight in different states of the flax-crop. Five roods, statute measure, were sown with the different kinds of seed noted below, a rood to each, and the quantity of seed was at the rate of three bushels per acre.

Seeds.	Weight when pulled.			Weight after steeping and drying.			Produce of clean Flax.	Produce of Seed.
	cwts.	qrs.	lbs.	cwts.	qrs.	lbs.	lbs.	bushels.
American . . .	12	3	7	4	2	0	42	$1\frac{7}{16}$
Riga	12	2	23	4	1	0	54	$1\frac{1}{4}$
Dutch	12	1	1	4	1	6	49	$1\frac{3}{8}$
Irish, saved from Riga . . .	13	2	14	4	0	3	70	$1\frac{5}{16}$
Riga, of the former year's import .	10	3	24	3	1	0	45	$1\frac{1}{8}$

From this table we would infer that the average weight of the crop as pulled is about five tons to the acre, after steeping and drying 32 cwt., and of clean flax 416 lbs., of seed $10\frac{1}{2}$ bushels. But as the season of 1846 was the worst for flax known in Ire-

land for twenty years, the produce is unusually small, and the yield of fibre is only an eighth, whereas it is generally a fifth, of the weight of dried flax straw. The general yield per acre averages in common years 40 stones, whereas this has only given 26 stones.

The analysis of Sir Robert Kane has reference to plants which have not perfected their seed. But as the seed is ripened to a certain extent before the flax is pulled, its analysis must be taken into account in estimating the matters which the crop abstracts from the soil. It is given as follows:—

	Ashes per cent.	Phosphoric Acid per cent.	Nitrogen per cent.
Capsules, with seed, contained	8·80	0·39	1·80
Husks of the capsules	6·54	0·38	1·50
Seeds	5·18	0·47	1·81

It will be thus seen that the husks contain a considerable proportion of useful matters available for food, and that they may be used advantageously along with the seed.

Notwithstanding the great value of flax-seed used as food for all the domestic animals, and its use in Great Britain in very large quantities, either in the simple state or when made into oil-cake, it is only very lately that flax-growers in these countries have saved it, the old wasteful system being to steep the plant with the seed on the stalks, under the impression that its separation would impair the quality of the fibre. As the seed has always been saved in Belgium and Holland from the very finest kinds of flax, it is astonishing that this ridiculous idea was not sooner exploded here.

It must always be a great object with the farmer to render a large proportion of his straw and inferior grain available as food for animals, to be consumed on the farm; a portion of the nutriment they contain being thus applied to the support of the cattle, and the remainder being again returned to the land in the form of manure, enriching it, and preparing it for the production of other crops. Under ordinary circumstances this is not always practicable to any considerable extent, and the great mass of straw is merely fitted for manure by the fold-yard system, which is confessedly wasteful of many valuable products of its partial decomposition with the manure and urine, which are evaporated and lost. But if a highly nutritive food, in small bounds, can be added to these bulky matters, a large quantity can be consumed by the animals, with much profit to the farmer, the mixture being equally palatable to them and advantageous to him. House-feeding cattle enables the greatest number of animals to be maintained at the least expense, but, on inferior soils, the food is not sufficiently nutritive to empower the farmer to adopt this system. The pur-

chase of oil-cake and other costly feeding materials is frequently unprofitable, but the production of flax-seed on the farm seems to meet the difficulty at once.

The very large quantity of oil-cake annually consumed in Great Britain shows the estimation in which this description of food is held. In the manufacture of this cake the seed is crushed between metal rollers, then ground under edge mill-stones, heated in a metal vessel, in which it is kept constantly stirred by machinery, and the oil then extracted by pressure. The residue is the cake. When made of the seeds of hot countries, India, Sicily, Egypt, or Turkey, it is tolerably pure; but the greater proportion made in England is from Russian seed, which is generally inferior, and very much mixed with the seeds of weeds containing a very small proportion of nutritious matter. The amount of oleaginous matters contained in flax-seed varies very much, and, in the produce of warm climates, is always the largest. Thus, the yield of oil from a bushel of East Indian seed is $14\frac{3}{4}$ lbs. to 16 lbs.; of Egyptian, 15 lbs.; of Sicilian, $14\frac{1}{2}$ lbs. to $15\frac{1}{2}$ lbs.; of Russian, 11 lbs. to 13 lbs.; of English or Irish, $10\frac{3}{4}$ lbs. to 12 lbs. It is evident that the expression of the oil renders the cake less valuable for feeding, as oleaginous matters contain a larger proportion of nutriment. The oil has been actually used, with considerable success, for fattening cattle, given with hay and turnips; and of late, in Rutlandshire, this practice has obtained to some extent. There is no doubt, however, that the seed is more wholesome. But by itself it should be cautiously given, as it is apt to act as a purgative. Of course this is obviated by an admixture of straw or other coarse substances.

To Mr. Warnes, of Trimingham, Norfolk, we are indebted for the most economical and efficient mode of using flax-seed as food for cattle, that has as yet been made applicable to the circumstances of the English farmer.

Black cattle have generally been fed in the way above described, but it is also adapted to sheep, which thrive very well and take on flesh rapidly. The compound is given four times a-day, about 4 to 6 ounces of seed to each animal.

For horses flax-seed is peculiarly suitable, and will enable them to do with a much less quantity of oats or other grain. Nothing more conduces to a silky and beautiful hide than this food—an unfailing sign of health in the animal.

To pigs also flax-seed may be advantageously given; and in the north of Ireland young calves are given a small portion, say $\frac{1}{4}$ lb. in the day, ground into meal, and about 2 quarts of milk added. The ground seed is made into gruel, by steeping it in cold water for 12 or 24 hours, and mixing it with the milk and a little lukewarm water at the feeding time. The quantity of seed may be in-

No. 1.

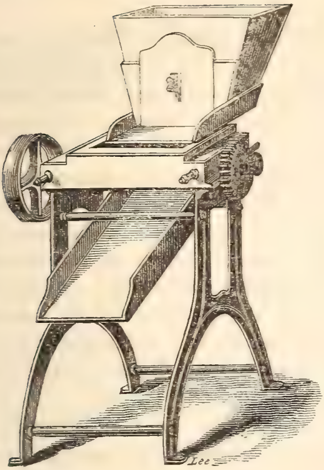

Fig. 9.

No. 2.

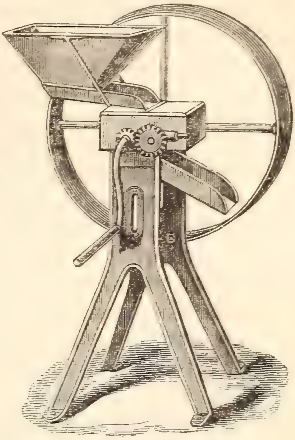

Fig. 10.

No. 3.

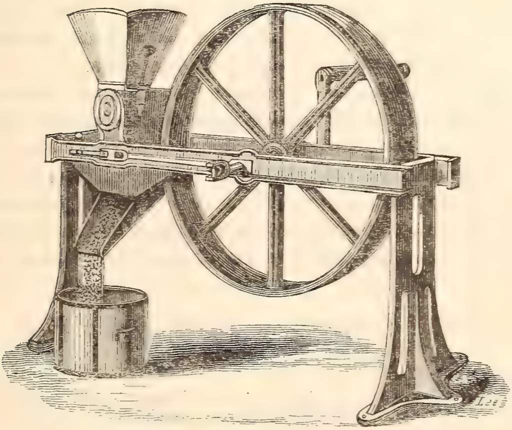

Fig. 11.

Fig. 9, by Mr. A. Dean, of Birmingham, for engine or horse power.

	£.	s.	d.		£.	s.	d.
Price, with Rollers, 9 inches long . .	5	15	0				
,, ,, 12 ,, . .	7	0	0				
,, with Fly-wheel	6	15	0	to	8	10	0

Fig. 10, by Mr. A. Dean, of Birmingham, for one person to turn.

	£.	s.	d.
Price	4	5	0

Fig. 11, by Messrs. Bond and Harwood, Ipswich.

creased, that of the milk lessened, and finally dropped, as the young animal increases in size. It is equally suitable, whether the calf is intended for vealing or to be reared.

In all cases where linseed is given, care should be taken to have it perfectly crushed or ground into meal. The outer part or skin of the seed contains a large quantity of mucilage, which water causes to form in a jelly on the surface, and it becomes so slippery that the animal finds it difficult to break it with the teeth, and numbers of seeds are thus passed whole, the gastric juice having only dissolved the gelatinous matter. For breaking the seed some very efficient machines are made by the agricultural implement-makers (*figs.* 9, 10, and 11, p. 393); metal rollers, either smooth or slightly grooved, being the general mode of crushing. It is better, in giving the ground seed, to steep it in cold water for several hours, since boiling renders it tough, while the former mode reduces the whole mass to a syrupy consistence, bursting the particles and thoroughly dissolving the mucilage.

Having now finished a detailed account of the management of flax both for fibre and seed, it may be advisable to present some notes as to the average profits of the crop.

It is very difficult to give a fair estimate for any kind of crop, since the expenses and the proceeds are so much influenced by the quality and composition of the soil, the value of labour in the district, and the nature of the season; and the difficulty is much increased in the case of flax, by the extent to which the degree of attention bestowed on the different operations in its management influences the yield and the quality of the fibre.

The annexed estimates, which are arranged from numerous results in England and Ireland, may be taken as the average yield in a favourable season, and at the average price of the fibre.

I have thought it best to give two estimates, No. 1 being for an acre, sown thinly, with a view to having a large produce of seed, which necessitates a coarser description of fibre, and No. 2 being for an acre sown more thickly, producing less seed, but a finer fibre:—

No. 1. *Expenses on* 1 *Statute Acre of Flax.*

	£.	*s.*	*d.*	£.	*s.*	*d.*
Rent and taxes	1	10	0			
Ploughing, harrowing, and rolling . . .	1	8	0			
2 bushels of seed, at 10*s*.	1	0	0			
Weeding, pulling, rippling, and steeping . .	1	2	0			
Taking from steep, spreading, turning, and lifting	1	12	6			
Scutching 38 stones, at 1*s*.	1	18	0			
Cleaning seed	0	10	0			
				9	0	6

	£.	s.	d.	£.	s.	d.
Brought forward				9	0	6
Produce.						
38 stones of flax (16 lbs. each) at 6*s.* 6*d.* .	12	7	0			
18 bushels of seed, at 6*s.* 6*d.*	5	17	0			
50 bushels of husks, at 4*d.*	0	16	8			
				19	0	8
Profit . . .				10	0	2

No. 2. *Expenses on* 1 *Statute Acre of Flax.*

	£.	s.	d.	£.	s.	d.
Rent and taxes	1	10	0			
Ploughing, harrowing, and rolling . . .	1	8	0			
$2\frac{1}{2}$ bushels of seed, at 10*s.*	1	5	0			
Weeding, pulling, rippling, and steeping . .	1	2	0			
Taking from steep, spreading, turning, and lifting	1	12	6			
Scutching 30 stones, at 1*s.* 4*d.* . . .	2	0	0			
Cleaning seed	0	6	0			
				9	3	6
Produce.						
30 stones of flax, at 9*s.* 6*d.*	14	5	0			
10 bushels of seed, at 6*s.* 6*d.*	3	5	0			
Husks	0	8	0			
				17	18	0
				8	14	6

In explanation of the above the following points must be noticed:—The value of the flax in No. 1 cannot be less than 6*s.* per stone under any circumstances of fair management, but that of No. 2 may reach as high as 15*s.* or even 20*s.* under favourable circumstances. The charge for scutching is higher in No. 2, as fine flax requires to be dressed with more care to guard against loss. In general it may be observed that the profits are usually pretty equal, whether the flax be grown primarily for seed or for fibre, the greater produce in the first case of seed, and the higher value of the dressed flax in the second, maintaining a just equilibrium.

It now remains for us to glance at the reasons for and against flax, and to inquire whether the general resumption of this culture at this time presents more advantages than formerly, and what these advantages are.

The first and great objection urged against flax is, that it is an exhausting crop, that it derives a large proportion of organic matters from the soil, rendering it unfitted, without manuring, to bear other crops luxuriantly. *Per se,* this is quite just, as flax does abstract a larger amount of nitrogen from the soil than many other crops commonly cultivated in Great Britain. In practice,

these evil effects, having become manifest, led landed proprietors to insert clauses in leases, prohibiting the culture of the plant. But if we consider the mode in which the plant was managed, we shall find that everything was taken off the land, while nothing was returned to it. The flax was pulled and steeped without the separation of the seed, which, of course, went to utter loss, and no portion of the water containing the decomposed matter, so rich in nitrogen, nor of the refuse stems, was economised for manure. It is therefore not to be wondered at, that flax culture got into discredit and was prohibited, more especially when peace brought the large supplies from Russia into our markets, and reduced the prices obtained in war time for this material. But at the present day, by the introduction of the careful system of our Continental neighbours in the manipulation of the crop, attention to saving the seed and its use for feeding cattle, and the striking analyses of Sir R. Kane, making known to us the value of the refuse parts of the plant, this objection has been completely set aside. If the fibre be composed chiefly of the elements of the atmosphere, secreted by the plant during its growth and then assimilated, it of course becomes manifest that the restoration directly of the steep-water and woody stem to the soil, and of the flax seed in the form of manure, after it has added to the farmer's profit by the nourishment of his live stock, will completely renovate the land and leave it as well fitted to produce any crop as before the growth of the flax. Or the same result may be attained by applying a manure of the same composition, and in the same proportion, as these substances.* It certainly would appear to be a wonderful provision of Nature, that the fibre which furnishes an article of clothing to such multitudes of the human race, should be produced at such small cost to the fertility of the soil, provided man exerts his industry and skill in following the hints which she gives. I conceive, therefore, that the objection as to the exhausting nature of flax, though perfectly conclusive as regards the former mode of management, has now no weight whatever, from the light which science has thrown on the economy of this plant.

The large amount of labour which is required in the growth and preparation of flax, before it can be placed in the hands of the manufacturer, requires a calculation of the circumstances

* Professor Johnson recommends the following manure, at the rate of 4 cwt. per acre :—

Bone-dust (or bones dissolved in sulphuric acid)	25 lbs.
Gypsum	10 „
Pearl-ash	20 „
Soda-ash (dry)	20 „
Slaked magnesian lime	25 „
	100

affecting the supply of hands in any neighbourhood into which it may be introduced. It must be taken into account that much of the work can be done by women and children, and the scutching may be executed by machinery, with a vast economy of labour, if necessary. It will be readily seen that in the district where labour is cheapest, the production of flax will be the most successful, since it can undersell localities less favoured in this point. For the same reason the small farmer or cottier can sell his flax for less than the large farmer, since the otherwise unemployed labour of his family will prepare his small patch of flax at a much less cost than the hired labour for which the large farmer has to pay. But the latter is placed in a more favourable position for realising the full value of the seed, in feeding his cattle, and hence the seed will be his primary object, while the fibre will be the primary object of the small holder.

The trouble which flax gives, in the various processes which it undergoes before it is ready for market, is often objected to. This, however, will not be considered of weight by the careful and enterprising, when they find that their profit increases in proportion to the care and skill exerted in the different processes of management.

Where labour is plentiful, and the farmer sometimes finds a difficulty in employing all the hands dependent on him—especially the weaker ones—the dressing of flax by hand is of great importance in affording them a productive employment; and it can be done at any time when there is a dearth of out-door work, and many poor women may be enabled to earn what will support them, when, otherwise, they would be thrown as a burden on the parish.*

The secondary advantages that would be derived from a general extension of flax-culture in Great Britain and Ireland are very important. The linen manufactures of the United Kingdom have now attained such a perfection, through improvements in machinery, and the peculiar adaptation of the people to manufacturing industry, that, in nearly every description of fabric, they have gradually taken the lead in most of the neutral markets of the world; and the continental nations are only able to sustain their home manufacture by hostile tariffs. There can be no doubt that, if home-grown flax were substituted for the bulk of foreign, in this manufacture, the quality of the fabrics could be much improved, and would still further influence their sale. The duty on foreign flax was reduced about 1825, and again, by Sir Robert Peel's tariff, to a merely nominal amount. Notwithstanding this, the

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* In the Belgian 'Enquête,' before quoted, is the following passage:— "Dans ces hameaux il n'y a pas de pauvres. Le travail du lin occupe toute la population pendant l'hiver."

growth in Ireland has increased considerably since that period, as the natural quality of the fibre is so much superior to the bulk of the import. There is no branch of British manufacture where the connexion between the agricultural and manufacturing interests is so direct, and no case where greater common benefit would be derived than from the extended cultivation of flax in these countries. At the present time, when the late changes in the laws regulating the import of foreign grain have brought the food-produce of all parts of the world into direct competition with the fruits of British soil, it is worthy of attention, that a vast number of countries are formidable rivals to us, from the suitability of their climate and soil for the growth of the cereal grasses; while with respect to flax, very few can compete on these grounds, and the amount of labour required in this culture effectually prevents any country, where there is not a superabundance of population, from producing it to any extent.

In conclusion, after reviewing the entire question, I am strongly of opinion, that the judicious introduction of this crop, managed according to the improved system, into districts suited for it, taking into account all the circumstances, already noticed, as favouring it in peculiar localities, would be productive of great benefit to British agriculture, in furnishing a valuable marketable produce,—in the economy of cattle-feeding and the production of manure,—and in the utilization of otherwise unproductive labour among a section of the working classes for whom it has been found very difficult to obtain work; while the nation, generally, would benefit from the retention, in future, of the large sums hitherto annually paid to foreigners for flax, flax-seed, and oil-cakes, and the improvement in different branches of native manufacture by which it would necessarily be accompanied.

APPENDIX.

Laboratory of the
Chemico-Agricultural Society of Ulster,
Belfast, April 26, 1847.

Dear Sir,—I inclose you a statement of the composition of the flax soils from Belgium, and also of the water of the river Lys, which you forwarded to me for analysis.—I remain yours very truly,

John F. Hodges,
Chemist C. A. Society.

Soil No. 1, from Courtrai.—Colour yellow brown, sandy; contained numerous white particles of carbonate of lime, and also some brick-red grains resembling pieces of decomposed sandstone. Its composition in 100 parts was as follows:—(See page 368.)

Soil No. 2, from Lokeren, in the Waes district, was of a greyish-brown colour, and appeared to consist of a fine white sand mixed with dark grains, and also some reddish mineral particles. It had the following composition in 100 parts:—(See page 368.)

Soil No. 3, from Ypres.—Colour somewhat lighter than No. 2; sandy; contained grains of carbonate of lime, and also some pieces of charcoal and decomposed sandstone of a yellowish-brown colour. Its composition was as follows:—(See page 368.)

Remarks.—The composition of the above soils certainly presents no characters which should induce us to regard them as peculiarly fertile. Even when large quantities of the soils were taken, but minute traces of phosphoric acid were observed. If therefore these analyses may be regarded as representing the usual character of the soils of Belgium, we must conclude that their superior productiveness is to be attributed rather to the skilful management of its industrious husbandmen, and the attention which they devote to the application of proper manures, than to any natural superiority of composition. In all the soils examined the amount of lime was considerable; and to Soils Nos. 2 and 3 it appeared to have been largely applied. This circumstance confirms the opinion which I have frequently expressed, that there is nothing in the composition of the soils of the great central limestone plain of Ireland likely to prove injurious to the flax plant. In the celebrated flax districts of Courtrai, Ypres, and Lokeren, from which the samples of soil were selected, I find that the fields from which they were taken had produced, for the two years preceding the flax crop, 1st, potatoes, upon farm-yard manure; 2nd, a crop of wheat, without manure. In the third year, for the flax crop, the ground was manured with cow-dung and necessary dung, or the refuse of rape-seed.

The Water of the river Lys.—The water was forwarded in a carefully-secured jar, and when received was quite fresh. It appeared muddy from a flocculent matter, which subsided upon standing. The sediment was examined by a powerful microscope, and when magnified 240 times lineally, was seen to consist of vegetable matter and the remains of numerous flax fibres. It also contained numerous species of infusory animalcules. The water, evaporated to dryness, exhaled a strong flax odour.—For analysis, see page 378.

Remarks.—There is certainly nothing in the composition of the above water, judging from its inorganic elements, to distinguish it from many streams and rivers in our own country. The amount of solid matter is indeed larger than is usually met with in our waters, and might be supposed likely to injure its qualities for steeping. In Belgium, however, the water of the Lys is recognised as peculiarly valuable for this purpose. A consideration of the nature of the organic matter contained in the water appears to indicate the proper direction in which our inquiries should extend. It is singular that the sample of water examined, which is stated to have been taken from the middle of the river, 300 yards above Courtrai, should contain at the present season so large an amount of decomposing vegetable matter, chiefly the remains of the flax plant. May not the water, charged with decomposing flax matter, be in the proper condition to commence and facilitate the decomposition by which the separation of the flax fibre is produced?

XV.—*Observations on the Natural History and Economy of a Weevil affecting the Pea-crops, and various Insects which injure or destroy the Mangold-wurzel and Beet.* By John Curtis, F.L.S., Corresponding Member of the Imperial and Royal Georgofili Society of Florence; of the Academy of Natural Sciences of Philadelphia, &c.

Paper XIII.

Curculio (Otiorhynchus) picipes. The pitchy-legged Weevil.

In my last Essay the history of two weevils was detailed which cause great mischief to the early pea-crops, and attack the broad-

beans also:* I now find that another species assists very materially in the destruction of these plants.

Last Midsummer Mr. George Gill sent me many specimens of a beetle alive; and informed me, "that they were making sad havoc in the vicinity of Kettering, in Northamptonshire, amongst several different plants, more particularly peas, turnips, and young winter-plants, as savoy, kale, broccoli, &c." A market-gardener in the same neighbourhood had 4 rows of peas, 70 yards long, destroyed by them, and the general crop much injured. About 8 poles of white turnips, just fit for the hoe, were eaten off in two nights, and the same quantity of winter-greens, nearly in a state for setting out, was also devoured.

During the day Mr. Gill observed the weevils remained in clusters under the soil, but as soon as the sun was set they came out and commenced their depredations, which they continued until 4 o'clock in the morning, when they again retired for the day. It is possible the Caterpillars of *Noctua segetum* and *N. exclamationis,* called surface-grubs,† might assist in the destruction of the turnips and winter-greens; but no doubt Mr. Gill is correct regarding the peas, for on putting 4 of the weevils into a box with some shoots of peas and horse-beans, in two nights they ate the holes in the stem and leaves as exhibited in the plate (fig. 1), as well as others in different parts of the plants.

This weevil is sometimes a dreadful pest in gardens, committing sad ravages on vines in hothouses and on wall-fruit, during the night, when they emerge from their hiding-places in old walls, from under the bark and clods of earth, to revel upon the branches of the new wood in April, or to feed upon the young shoots, which soon become black. They likewise injure raspberry plants in spring by eating through the flowering stems and leaves, and they nibble off the bark, and eat out the buds of apple and pear trees as early as February or March. ‡

The larvæ also (fig. 7, 8 the same magnified) are very destructive to the roots of flowers and various plants in the autumn, winter, and spring, when they change to pupæ (fig. 9, 10 the same magnified), in which state they remain probably not more than a fortnight.

The larvæ or maggots are fat, whitish, and wrinkled, with horny hazel-coloured heads: they lie generally in a curved position, and having no feet, remain feeding under ground, pretty nearly in the same spot where they were hatched. Having arrived at their full growth, they form an earthen cell, and change to a torpid pupa of a whitish colour, with black eyes, exhibiting through the

* Jour. Royal Agric. Soc., vol. vii. p. 405. † Ib., vol. iv. p. 100.
‡ Gardeners' Chron., 1841, p. 292.

skin the limbs, folded up, of the future beetle. The horns, rostrum, and legs are compactly arranged, and the small wing-cases are wrapped round the sides, exposing the body. From this pupa issues the beetle or weevil, which is included in the ORDER COLEOPTERA, the FAMILY CURCULIONIDÆ, and the GENUS OTIORHYNCHUS, or Curculio, and is described by Fabricius as

1. C. picipes; but Marsham gave it the name of *Curculio vastator*, from its destructive habits. It is of a clay-brown colour, and so exactly partakes of the complexion of the soil, that when it remains at rest or with the limbs contracted, as it falls down when disturbed, it is scarcely possible for the eye to discern the creature. The horny covering is curiously tuberculated, and sprinkled over with minute scales, more or less inclining to white, yellow, or coppery. The head is produced into a short stout rostrum, which is dilated at the apex by 2 cavities like nostrils, in which the horns are inserted: these are chesnut-brown, hairy, and 12-jointed; the basal joint is long, and forms an angle with the remainder; the 2nd is short and oval; 3rd twice as long; 5 following, globose; the rest forming an ovate-conic club; the eyes are lateral, black, and orbicular; at the extremity of the rostrum is placed the mouth, which is composed of 5 distinct pieces: the 2 mandibles or jaws (fig. 4) are horny and strong, terminating in a pointed tooth, with a smaller one inside: the maxillæ, or second pair of jaws (fig. 5), are also strong, with a spiny lobe, and a bunch of long hairs beneath, with a triarticulate palpus or feeler on the outside (fig. *c*); the mentum or chin (fig. 6) is oval, concealing the lip and producing 2 minute biarticulate palpi or feelers (*d*): the thorax or trunk is subglobose, and twice as broad as the head: the wing-cases are soldered together; they are very convex, oval, and clouded, with 20 rows of pale dots formed by scales: wings none: legs 6, strong and hairy; thighs stout, notched beneath; tibiæ or shanks flexuose, dilated at the apex and pectinated; feet 4-jointed—2 basal joints reverse—trigonate; 3rd, bilobed; 4th, clavate, terminated by 2 minute claws: fig. 2, the weevil reposing; fig. 3, the same walking, but magnified.

From the great variety of trees and vegetables on which these weevils will subsist, it seems scarcely possible to guard against their inroads. As they are unable to fly, when they attack the pea-crops no doubt they sally forth from the hedge-rows, which frequently swarm with these beetles, for I have found them in multitudes, feeding on black-thorns, elms, lime-trees, &c., in May. A dressing of salt or gas-lime would, I expect, destroy the larvæ, as either will the maggots of nuts; but we seldom know where they are deposited at this stage of their existence, and the beetles are safer in their horny coats than a tortoise in his shell: nothing but boiling water or spirits of turpentine seems even to annoy them. It is difficult, therefore, to apply any remedy except hand-picking. The crops in nurseries have been preserved by men going out at night and drawing the branches through their hands, and putting the weevils into large-mouthed bottles,

as well as by shaking the branches over sieves, which were emptied into pails of water. The beetles are, however, so timid and wary, that they are most successfully collected without lanterns; and if lights be used, the infested plants must be very cautiously approached, otherwise the weevils will fall down and escape. Possibly by dusting with soot, lime, or wood-ashes, and watering with gas-water, the ground might be made disagreeable to them; and rows of young peas might be, in a measure, protected by boards, 3 or 4 inches high, set on each side, and sloping outward. As soon as the peas make their appearance above ground the boards should be tarred on both sides, so that the beetles could not surmount them, and many of those enclosed between the boards would, no doubt, be caught by the adhesive tar.

We are, however, indebted to a genus of sand-wasps for reducing the numbers of these pests, which could not otherwise be kept in check. Their services are unceasing and invaluable—and it is a law of nature that as the insect-plague spreads, the parasites that prey upon them increase in an equal or greater degree, until the mischief is subdued. Some of these sand-wasps often appear in vast numbers, especially in gravelly ground and sandy banks, where they form burrows to lay their eggs and rear their young, and for this purpose some species fly abroad in search of a group of wild bees called *Andrena,** whilst others are engaged in collecting the weevils, which they bury in their subterranean nests, to feed their young maggots as soon as the eggs hatch. In the gravel-walk of a garden at Boulogne-sur-mer, in August, there were innumerable holes made by these sand-wasps, and the females were busily occupied in carrying home a species of weevil closely allied to the *Otiorhynchus picipes,* and described under the name of *O. scabrosus.* On digging about a foot deep I found several of the beetles which had been thus buried, the contents of whose bodies had been completely emptied out, and nothing was left but the horny shells.† *O. sulcatus* is another species; they have been detected carrying alive between their legs: and a different genus of weevils, called *Strophosomus,*‡ has been recorded as falling a prey to them.

These sand-wasps are of the Order Hymenoptera, Family Cerceridæ, and Genus Cerceris. The species which buries the weevils is named by Linnæus

2. C. arenaria, but it is the C. læta of Fabricius. The *female* (fig. 11) is black, thickly punctured and pubescent; the head is large,

* Curtis's Brit. Ent., fol. and pl. 129. † Curtis's Brit. Ent., fol. 690.
‡ Curtis's Guide, Genus 374b; and Shuckard's Fossorial Hymenoptera, p. 235.

armed with strong jaws, &c.;* the larger eyes are long, vertical, and lateral; behind them is a yellow spot, and inside, on the face, is a patch, a small spot, and between them an oval one on the nose, all yellow; on the crown are 3 minute eyes called Ocelli, forming a triangle; the short curved horns are inserted in front of the face, and are 12-jointed in the females; they are rusty beneath at the base, the 1st joint being the longest and stoutest; 2nd, globose; 3rd, slender and longer than the following, which are a little oblong, the terminal joint ovate: thorax convex, oval; 2 yellow spots on the collar, a transverse one behind the scutellum, and an oval one on each side of the metathorax; scapulars yellow also: abdomen long and elliptical, attached by a narrow base; the segments contracted at their union; 6-jointed; 1st joint small, pear-shaped, with a yellow lunate spot on each side; 2nd, large, cup-shaped, yellow, with a black triangular space at the base, 2 following with narrower yellow margins, 5th with the yellow margin broader; apex with 2 elevated lines, forming an ellipsis: wings 4, tinted with brown, especially at their tips; superior ample, with a small rusty stigma; 1 marginal and 4 submarginal cells, the 2nd attached by a short nervure: legs 6, strong, orange-coloured; trochanters black, as well as the base of the 4 anterior thighs; shanks spiny outside, spurred at the apex; feet 5-jointed, ciliated, with spiny appendages outside, and terminated by 2 claws and pulvilli.—*Male* smaller, face more yellow with a yellow patch under the basal joint of the antennæ, which are 13-jointed; yellow marks of the trunk smaller, the 2 spots on the metathorax wanting, and those on the basal segment of the abdomen are only minute dots; there are 7 segments with 5 yellow bands, more equal than in the female; the thighs are blacker, and the hinder pair are black also, excepting the base; the hinder tibiæ are likewise blackish at their extremity, and the forefeet are not ciliated with spines.

'Economic entomology,' or a knowledge of those insects which injure cultivated crops, is so vast a field of discovery, that every season brings forth fresh subjects for investigation; and although this arises in a great measure from the neglect which has attended this important department of natural history, it seems as if a cycle were revolving, which exhibits species previously unobserved, at intervals of greater or less extent; and whether regular or irregular cannot be determined for want of data: rare and unnoticed species, no doubt, become abundant or scarce by changes of temperature; certain and continued currents of air, a want of food in their accustomed localities, and similar phenomena, may also change the regular course and geographical distribution of insects for a season; so that enemies to the cultivator may suddenly become great annoyances in latitudes where they had been previously unknown; and may there remain until a counter-action takes place, either of climate or by parasitic agency, which at once sweeps away the plagues and releases us from those great armies which are employed by the

* Curtis's Brit. Ent., pl. 269, for the dissections, &c.

Power who created them. These are profound and mysterious subjects which we cannot fathom, yet the divine book of nature is open to all; but it will only prove profitable to those who have a thirst for knowledge, and who delight in contemplating the wonderful works of the Creator.

During the past summer the prodigious swarms of Aphides* which suddenly covered the young shoots and under sides of the leaves of almost every plant, so that the surface was blackened by them, was unprecedented, as far as can be ascertained, and it excited the attention of the public generally. The migratory locust,† which is an awful visitation on the Continent,‡ has this year also reached our island. I have had several transmitted to me from various counties; and during a short stay on the eastern coast last August, I saw six specimens which had been captured in a wheat-field by the gleaners, yet in all probability neither the aphides nor the locusts will be present next year; indeed, the former died in closely-packed groups, with their beaks thrust into the leaves, and their wings erect; and possibly were either poisoned by feeding upon juices not adapted to their constitutions, or they might have been held fast by the drying of the leaves in which their rostrums were imbedded. A still more remarkable instance of the sudden appearance of insects, and the destruction of crops hitherto free from such depredations, we shall give in the development of the economy of those species which affect the mangold-wurzel.

Silpha opaca. The Beet Carrion-beetle.

Dickson § says, that mangold-wurzel is not injured by insects or drought; and such appeared to be the case until the last two or three years, when in France and Ireland the larva of a beetle made its appearance in sufficient numbers to carry off entire crops, and I find it now has several insect enemies to contend with.

There is a carrion-beetle called *Silpha opaca,* which was known to Linnæus, and is common enough in dead animals in April: it has also been found in February at the roots of trees, where, probably, it had wintered. In May I have detected it under stones in sandy warrens, and also on the flowers of the

* From a careful examination of these insects, I consider them to be identical with the bean-plant louse, *Aphis fabæ;* and Mr. Francis Walker entertains the same opinion. *Vide* Royal Agric. Jour., vol. vii. p. 416, pl. R, figs. 20–23.

† The history of this insect will be given when we come to the pasture-land.

‡ *Vide* Kirby and Spence's Introd. to Ent., 6th ed., vol. i. p. 185.

§ Practical Agriculture, vol. ii. p. 723.

mountain-ash; it seems therefore probable that it will live upon caterpillars; and Dr. Calvert, some years since, sent me specimens he had found in his wheat-fields in Yorkshire, which he suspected injured the corn. The most remarkable trait in the economy of this insect is, that its larva will feed upon the leaves of the mangold-wurzel, for it had always been considered to live, like its parent the beetle, upon putrid animal substances. Mr. Haliday, however, has found a few larvæ of a *Silpha* at the roots of artichokes in Ireland, and they are also abundant under marine rejectamenta there; it is therefore possible that they feed upon sea-weeds and any succulent or gelatinous vegetables which approach animal substances in texture and fleshiness: but here again, if such be the case, is a considerable difference in the habits of the insects; because the larvæ hitherto known, only live upon *putrid* animals, such as dead birds, rabbits, hares, hedgehogs, &c., whereas those I am about to describe feed upon the *fresh*-expanding leaves of the mangold-wurzel.

In June, 1844, my attention was first called to this subject by W. Ogilby, Esq., who sent me specimens of the larvæ, forwarded to him by the Rev. Edward Bowen; and he informed me that they had eaten off all the mangold-wurzel on the farm of John Ferguson, Esq., of Castle Forward, Londonderry. Nothing further occurred until I received a communication from the Rev. C. Maxwell, of Birdstown, Londonderry, dated 31st May, 1846, with one of the larvæ, and stating that his mangold-wurzel was being devoured by this animal; and, on June the 9th, he added that every plant had been annihilated. The field had been entirely dressed with common farm-yard manure: on the 23rd of April, about half a rood of carrots and the same of parsnips were sown; next in order an acre of mangold-wurzel, then Swedish turnips; and, on the 1st of May, beet-root. Every crop promised to succeed, except the mangold-wurzel, which was destroyed by the larvæ alluded to. They were to be seen in large quantities in the mangold-wurzel ground, but none in that portion of the field under other crops. Subsequently, however, the beet-root was assailed by the same insects: it seems the crop was attacked almost as soon as it appeared above ground, viz., about the 21st of May, and the larvæ disappeared at Midsummer, for only two could be found on the 24th of June; they were then in the pupa state, or might be starved for want of food. It is the leaves they devour, leaving only the fibres. In 1847, Mr. Maxwell says, in a letter dated June the 12th, "This destructive animal has again visited the same crop this season, at the same time of the year, and under similar circumstances; but in greater numbers and with increased injury to the crop. The specimens transmitted are

smaller in size than those sent last year: not yet, I presume, having attained their full growth. The crop is so totally destroyed, that it is of no use attempting any method to remove the insects by lime or otherwise; but it would be very satisfactory to ascertain their origin, and by judicious measures to prevent their reappearance at a future time. The mangold-wurzel is the only crop attacked in a field sown with potatoes, turnips, peas, and beans." With the larvæ were enclosed some of the leaves which were amongst the least injured, the greater part of the plants having been completely eaten down to the root.

I learn, by a recent communication from Mr. Ogilby, that the depredations of these larvæ are not confined to Londonderry, for they have made their appearance this year upon his property in the next county of Tyrone. He says, "A much larger breadth of root-crops of all kinds, including mangold-wurzel, was put down last year by my tenants than during any former season; partly owing to the failure of the potato-crop, and partly to the offer of very large premiums on my part. Turnips, parsnips, carrots, and cabbages have succeeded admirably; but of the mangold-wurzel the whole crop was cut off by the insects, before the cotyledon leaves had well penetrated to the surface—as soon as ever they appeared the plants were attacked, and I may almost say that they were never seen, so rapid was their destruction. One crop, and, as far as I am aware, one alone in my neighbourhood, that of the Rev. Mr. Brownlow, of Alla, succeeded—or, I should rather say, escaped."

In manuring Mr. Maxwell's field, no bones or offal, beyond what might have been accidentally thrown on a dunghill, had been used. This was in answer to my supposition that these larvæ had been introduced into the mangold-wurzel fields with the manure, either bones or seaweed; such does not appear to be the case; but with the few facts we have at present collected relative to this new pest, attention must be given to every collateral bearing. It seemed desirable to report Mr. Maxwell's observations as fully as possible, in order that the subject may be carefully investigated, lest the cultivation of this valuable crop should be abandoned in Ireland; and it is very remarkable that although the insect is abundant in England, I have not heard an intimation of its appearance upon the mangold-wurzel. Indeed, at present, it is unknown on this side of the water as an enemy to the agriculturist.

It is not so, however, in France; for we learn from M. Guérin Méneville,* who is indefatigable in the pursuit of every branch of entomology, and has lately devoted himself to investigating the

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* Annales de la Soc. Ent. de France, for 1846, p. lxxii.

economy of the insects affecting the various crops of France, that M. Bazin had sent him many larvæ of *Silpha opaca,* which were more elongated than in the other known species: they were shining-black, with a little yellow at the anterior margins of the segments; they were found in great numbers in some red-beet fields, and were accused of devouring the leaves of this useful plant, and thus causing great ravages in the plantations when the plants began to sprout. M. Guérin saw them eat the leaves of the red-beet which he gave them, as caterpillars would have done. M. Bazin and his son had detected these larvæ in their fields in great numbers, mounted upon the leaves of the plants and eating them.

The distance from Londonderry being so considerable, the larvæ transmitted by post did not reach me alive; and consequently I never had a chance of rearing the beetles to identify them. M. Guérin has been more fortunate, for at the beginning of July he saw a larva change to a pupa; the middle of the same month many buried themselves three or four inches in the earth, making a little oval cavity by kneading the soft earth with their head, aided by pressure exercised by the back, &c. On the 14th he saw a white pupa; and on the 24th the *Silpha* hatched. It remained two days white in the earth, gradually becoming brown, and eventually black, when it came forth. Some of Mr. Maxwell's larvæ also changed to greyish-white pupæ, about three inches below the surface of the soil, but he did not obtain the beetles from them.

It is quite possible that these larvæ may be the offspring of different species of the *genus Silpha,* yet I am disposed to think the French and Irish are the same, supported as this supposition is by their similar economy. I observed some of the larvæ were longer and narrower than others, which may be merely a sexual variation. It is not that they assume the broader form before being transformed into pupæ, for many of the small and young ones were equally short and broad in proportion. I think the one found at the artichoke-roots is not the same species as those from the mangold-wurzel, for the antennæ are longer and stouter; and whether those Mr. Haliday has observed under marine rejectamenta are identical with the former I cannot ascertain at present.

These insects belong to the ORDER COLEOPTERA, FAMILY SILPHIDÆ, GENUS SILPHA, and the species is referred to *S. opaca.*

The eggs are laid probably in the earth, but this remains to be proved; and the larvæ must have been hatched ten or twelve days when first observed, as they were 2 lines long (fig. 13); when full-grown they are 4 or 5 lines long (fig. 14). They are very much the

form of woodlice (*Onisci*) as shown at fig. 15, but are black and shining; comprising 13 segments, including the head, which is somewhat orbicular, with two impressions on the face; and the mouth is composed of 5 pieces: 2 mandibles or jaws (fig. 17), which are horny, cleft at the apex, forming 2 sharp minutely serrated teeth, and inside is a duplicate lobe (fig. 18), of similar form, but shorter; this is a member which I have not met with previously, and has no analogue in the perfect beetle. Below the mandibles are two secondary jaws called maxillæ (fig. 19), which are articulated and terminated by a broad hairy lobe, and to the outside is attached a longish palpus or feeler (fig. *g*), which is 4-jointed, the apical joint conical; between these is placed the chin (fig. 20), with a short cleft lip (fig. *h*), and on either side is a short stout tri-articulate palpus or feeler (figs. *i i*): the eyes are composed of 4 minute lenses, situated above the antennæ, which are inserted in cups on each side of the head; they are rather short, slender, hairy, and 3-jointed (fig. 21); the basal joint is cylindrical and scarcely longer than the second, which appears to be notched inside near the apex, the third is slenderer and elongated: the thorax comprises 3 segments, the first being the largest; they have the angles rounded, but in the following segments they are acute and give the sides a toothed appearance; the apical segment, however, is furnished with an acute spine on each side. It has 6 short legs, which are 5-jointed; being formed of a hip, trochanter, a thick thigh, slender shank, and a strong acute claw (fig. 22). In some specimens the body had a narrow tawny margin (fig. 15), whilst others were narrower and more elongated (fig. 16; *f*, the natural length.) When full-grown the larvæ bury themselves, and forming cells, change to pupæ in the earth, and from these emerge the beetles called

2. Silpha opaca by Linné, but De Geer named them *S. tomentosa*, from their being clothed with short, tawny, depressed hairs, which are generally worn off in a short time, when they appear black, and exceedingly thickly punctured all over, the hairs having been inserted in these minute pores: the head is very much the form of that of the larva, and the organs of the mouth are not very dissimilar,* but the eyes are large and oval, the horns are twice as long, clubbed, and 11-jointed; basal joint the longest, 2nd longer than the third, 5 following more or less globose, the remainder forming a sort of club, the terminal joint reverse—pear-shaped: the thorax is twice as broad as the head, somewhat transverse-oval, the surface undulating from impressions; scutellum rather large and triangular: wing-cases depressed, yet slightly convex, the outer margin reflexed, and there are three fine sharp ridges down each, curved next the hinder margin, which they do not reach, the outer one being considerably the shortest, and beyond the middle is a bump between the 2nd and 3rd striæ: the wings are ample, and folded in repose: the 6 legs are stoutest in the *male* (fig. 23); the shanks are spiny and spurred at the apex; the feet are bristly and 5-jointed, the 4 anterior with the 4 first joints dilated in the male, especially the first pair; 5th joint clavate,

* Curtis's Brit. Ent., fol. and pl. 742, where dissections and a coloured figure of the beetle are given.

and furnished with 2 strong curved claws. The *female* has slender feet (fig. 24, represented flying and magnified).

It would be advisable to try experiments for the expulsion of these larvæ when they trespass upon our crops; for at present no natural check to their multiplication has been noticed, and it is possible there may not be any parasites to prey upon them. Mr. Maxwell says, "neither salt nor lime seems to have the smallest effect. I have tried both with no successful result." To hand-pick them appears to be hopeless, owing to their small size and great numbers; but probably some trap might be invented to decoy them to certain spots, where they could be more readily destroyed in masses. It would not be amiss to distribute sea-weed when they appear on crops near the coast: dead birds and quadrupeds, as well as tiles and boards, should be placed between the ridges, to ascertain if they preferred any of the decomposing animals to the mangold-wurzel, or would congregate under sheltered spots, like woodlice, earwigs, &c. As the parent beetles can fly, something may attract them to particular spots where they pair and lay their eggs; and these are important points to be ascertained in their economy. From the larvæ being so young when discovered, it is evident they must have been bred in the field, if not actually upon the quarter where the mangold wurzel was sown. I am not inclined to think the eggs were introduced with the seed; yet it is not impossible, for we have testimony that the beetles have been found inhabiting the flowers of the mountain-ash, but for what purpose they resorted there is not discovered. Some of the seed previously to sowing should be subjected to sufficient heat to kill the eggs without destroying the vitality of the seed; or, by steeping it in brine, sowing it away from the rest, and examining it as soon as the larvæ made their appearance upon the crop raised from the unprepared seed, this important point would be settled, should there be no larvæ upon the plot experimented upon. A careful examination of the seed from an infected field should be made, to see if the eggs could be detected, for they must be very abundant to produce such large families; and repeated search ought to be made for the beetles upon the mangold-wurzel plants, especially those running to seed after the middle of July, when the Silphæ or beetles hatch, which are now made known by the figures in the plate (23 and 24), as well as by the descriptions. By such modes of experiment and search as are here recommended, and of course by others which will suggest themselves to the intelligent agriculturist, valuable facts will be collected, and good results may be expected.

Since the foregoing statements were made, I have received a communication from Mr. Maxwell, dated 4th of October, 1847,

which greatly alters the aspect of this visitation; for it seems the farmer need not despair of a crop recovering from the depredations of these larvæ. Mr. Maxwell says, "The beet-root plants which remained after ploughing up the field, and whose leaves suffered in the manner represented to you, have altogether recovered from their injuries, and are in a most flourishing state; so much so, that from my experience of this year I should certainly not recommend the course adopted last year, but trust to the plants recovering the injuries sustained by them during the month of June, before the larva has buried itself to undergo its transformations. I observed again that the larvæ totally disappeared about the 1st of July, appearing first on the 4th of June. Most undoubtedly the leaves are the only part of the plant fed on by the insect, the roots being perfectly untouched."

Cassida nebulosa. The Clouded Shield-Beetle.

M. Bazin, a proprietor at Mesnil St.-Firmin, to the south of Paris, detected in 1846 considerable numbers of the curious larvæ of this beetle feeding upon the leaves of the red-beet. They reside on the under side of the leaves, which they nibble by degrees in small round spaces, and the leaves are thus riddled with little holes.* They also inhabit *Chenopodium hybridum* (the Maple-leaved Goosefoot), and feed upon the leaves in July.

The larvæ are of a pretty green colour, marked with white, and the margins of the body are armed with barbed yellow spines (fig. 25); they are oval and depressed, with a small scaly head, furnished with teeth and three minute eyes in an oblique line, like little black tubercles, and four others higher up; each side is furnished with sixteen sharp spines, which are very bristly; at the extremity of the body are two long spreading tails, which the animal turns over the back when at rest, to support its shrivelled cast-off skins and excrement, which, like a parasol, shade it from the sun, and also protect it from being stung by parasites, but these tails are stretched out when the larva walks: the six pointed legs are concealed beneath the thorax. When they are prepared to change to pupæ, they fix themselves by the under side of the belly to the leaf which nourished them, and partially throw off their skin in two or three days. The appearance of this pupa is more remarkable than that of the larva; it is oval and depressed, with a large shield-like thorax entirely concealing the head; the margin is ciliated, and there are two white spots on the back; the segments of the body are cut on the sides like the teeth of a saw, the terminal one is spiny, and produces a forked tail: it is of a bright and lively green colour, with the margins of the thorax and abdo-

* Annales de la Soc. Ent. de France, for 1846, p. lxxi.

men whitish, and along the back are two yellowish-white stripes (fig. 26).* In less than a fortnight, viz., about the beginning of August, the Cassidæ hatch.

They belong to the ORDER COLEOPTERA, FAMILY CASSIDÆ, and GENUS CASSIDA, or Shield-Beetles, and this species was named by Linnæus—

4. C. nebulosa. When first developed it is green, but it gradually becomes of a tawny colour above and black beneath (fig. 27; *k*, the natural length); the little head is concealed under the large semi-orbicular thorax, which is stamped with minute impressions, having two white spots at the base; the black eyes are oval; the horns are inserted on the forehead, and are 11-jointed, slightly thickened, and blackish towards the extremity, which is pointed; the scutellum is rather small and triangular; the wing-cases are oval and convex, with a flattened margin; there are five double rows of punctures on each, with black dots sprinkled over them: the two wings folded beneath are ample: the legs are short; the feet are 4-jointed, with the third joint bilobed, the fourth furnished with a pair of claws.†

The larvæ sometimes fall victims to a parasitic fly, notwithstanding the protection we have alluded to; for M. Guérin says, one which was not transformed to a pupa, produced, on the 25th of July, from the middle of the back, thirty-nine very little Chalcidites,‡ black, with yellow legs, the eggs of which had been deposited by the mother upon the living larva.

ALTICA NEMORUM. The Turnip Beetle or Fly.

Since my Essay upon this insect was written,§ I have detected the little beetles hopping about the mangold-wurzel and puncturing the leaves. Mr. Rootsey of Bristol has also made the same observation.

ANTHOMYIA BETÆ. The Mangold-wurzel Fly.

It is generally supposed that animals closely related to each other, and forming a natural group, would not be very unlike in their habits of life, but such is not always the case amongst insects, in their larva state especially, and the genus of flies called *Anthomyia* is a remarkable example of such a diversity. There are several species that annoy the farmer and gardener, which bear so striking a resemblance to each other in their fly state, that, except to the scientific observer, they would be considered as the same species, yet nothing can be more different than the economy of the larvæ. Some of these maggots live upon the seeds of the

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* De Geer's Hist. des Ins., vol. v. p. 168.

† Vide Curtis's Brit. Ent., fol. and pl. 127, for figures and dissections.

‡ Annales de la Soc. Ent. de France, for 1846, p. lxxi.

§ Journal of Royal Agric. Soc., vol. ii. p. 193.

lettuce whilst growing upon the plants; others revel in the decaying stems of cabbages, the bulbs of turnips and of onions; whilst others reside between the two skins of the leaves, feeding upon the pulp—and these have received amongst naturalists the name of miners. A gentleman at Cranford, who is well known for his scientific researches,* has made me acquainted with a fly whose larva mines in the leaves of the mangold-wurzel, and I am indebted to him for the following sketch of its economy:—"The maggots were brought to me from Surrey on the 26th of June, found feeding between the plates of the leaves, the integuments of which they cut rapidly, giving the parts attacked a blistered appearance. They were of a greenish colour, a quarter of an inch long, pointed at the head, and rather abruptly cut off at the tail: they turned to pupæ *in sitû,* as you may see by the fragments of the leaves, and hatched July the 17th and 20th: Mr. Frogley told me they had destroyed the plant where he got them from. I found my sugar-beet attacked in the same manner, but immediately employed some boys to pinch the blisters between the finger and thumb, and by attacking them in that helpless situation their operations were effectually stopped."

I may remark, that the maggots are very similar to those of the turnip;† like them, they change to an oval brown pupa, and from them issues a fly which exceedingly resembles *Anthomyia Ceparum,* which is bred from putrescent onions, but, as I cannot imagine they are the same species, I must distinguish them by naming the former, and shall call it after the beet or mangold-wurzel:—

5. A. Betæ. The *males* only are known at present: they are much smaller than the Onion-fly, being only 2 and $\frac{2}{3}$ lines long, and expanding about 5 lines: they are of an ashy-grey colour, clothed with black bristly hairs; head semi-orbicular; eyes large, brown, nearly contiguous above, with 3 minute ocelli on the crown; face satiny-white, with a bright chesnut-coloured line down the middle, in the centre of which are placed the little black drooping horns, the 3rd joint being the largest, elliptical, and producing a naked bristle on the back; the protruded lip and palpi are also black: on the trunk are 3 or 5 indistinct longitudinal stripes; the 6-jointed abdomen is linear, with a dorsal black triangular spot at the base of 4 of the segments; the 2 wings are ample and transparent, a little tinted with tawny at the base; the nervures are pitchy; poisers ochreous; 6 legs, longish, bristly, and pitchy, the shanks with a tawny tinge.

These insects will seldom cause any loss to the mangold-wurzel crops, should they ever abound to any extent; but whether they would prove injurious to cattle when the *leaves* are given as

* Mr. F. J. Graham, author of a Prize Essay upon the Potato Disease.
† Royal Agric. Jour., vol. iv. pl. H, figs. 35 and 36.

food I am not prepared to say, but I should think not, as the skins are very tender. I have seen the leaves of docks and burdocks as well as the celery,* blistered from the mining of the maggots of different species of flies to a large amount, and the only remedy is to nip them in the leaf, for they are so delicate that a very slight pinch will maim them. Parasites no doubt keep them under, and we may trust to them for assistance.

TIPULA OLERACEA. The Crane-fly, or Daddy-long-legs.

This universally distributed and mischievous gnat, by dropping its eggs in the field, garden, and pasture-land, annually causes serious losses to the cultivator by the destruction of various crops as well as flowers.† Not having space to illustrate the insect here, I shall leave its economy for a future opportunity, and merely state now, that two crops of mangold-wurzel plants were successively carried off by the larvæ, or grubs, as they are called, which are the offspring of these flies, in the spring of 1845, near Southall, in Middlesex; and in the second week of June they destroyed a large plot of the same plants in a field at Hayes. On examining the dead and dying plants, we found the maggots about an inch below the surface of the soil, and close to the roots of the infested plants, which had been eaten through by them. As they swarm in all grass-lands with other allied species, it is not safe to sow beet or turnips immediately after pasture-land has been broken up, without previously paring and burning, salting, or liming the land.

In the autumn, if the crown of the mangold-wurzel begins to rot, it is immediately taken possession of by numerous varieties of insects. I remember, at the end of October, 1846, finding vast numbers of specimens of a small beetle called *Cercyon boletophagum*,‡ which were inhabiting the cavities eaten probably by slugs. It is very smooth and shining, oval, of a pitchy colour, with the tips of the elytra, or wing-cases, ochreous; the clubbed horns and legs are tawny; it is not larger than a small turnip-seed. With them were multitudes of a minute, shining, tawny *Acarus*, oval in form, and looking like seeds when the six short legs were folded up. It appears to be the *Acarus*, or *Uropoda umbilica*, which attaches itself to beetles.§

This terminates the history of the insects which more or less injure the mangold-wurzel crops, and the following is

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* The maggots in the dock-leaves produce a fly called *Anthomyia solennis*. Those in the celery-leaves change to a handsome fly named *Tephritis Onopordinis*. Vide Gardeners' Chronicle, vol. i. p. 660.

† Gardeners' Chron., vol. i. p. 612.

‡ Curtis's Guide, Genus 115, No. 9.

§ Journal of Royal Agric. Soc., vol. v. p. 226, pl. J, fig. 49.

A Summary of the present Essay.

A *Weevil,* called *Otiorhynchus picipes,* destroys the young *pea-crops,* &c.

The Weevils *conceal* themselves by *day,* and *feed* only at *night.*

The same *Weevils* injure vines, wall-fruit, apple and pear trees, raspberries, &c., early in spring.

Their larvæ or *maggots* live in the earth upon the *roots of flowers,* &c.

They change to *pupæ* or chrysalides in the *earth.*

These *Weevils* swarm in *hedge-rows* in May, feeding on blackthorn, elm, and lime leaves.

The *larvæ* might be *destroyed* by a dressing of *salt* or *gas-lime.*

Dusting with *soot, lime,* or *wood-ashes* might banish the beetles, or *watering* with *gas-water.*

Tarred boards would protect *garden-crops.*

Hand-picking the most effective remedy in *nurseries.*

Sand-wasps, called *Cerceris,* capture the *Weevils* and bury them to support their young when the eggs hatch.

They *swarm* in some *sandy situations,* where the paths, banks, and gravel-walks are riddled by them.

Insect plagues suddenly *appear* from changes in the *atmosphere,* and as suddenly *disappear* through the agency of *parasitic tribes,* &c.

Bean Aphides swarming on almost *every plant* last summer.

Migratory Locust also not uncommon in various parts of *England.*

Mangold-wurzel supposed formerly to be *free from* the attacks of *insects.*

Larva of a beetle, called *Silpha,* feeds upon the leaves, and destroys the young plants in May and June.

They have been detected in the *North of Ireland* and in *France,* doing great mischief from 1844 *to the present time.*

In 1844, 5, *and* 6 they seemed confined to *Londonderry,* but in 1847 they carried off the crops in *Tyrone.*

They leave only the *fibres of the leaves,* but do not touch the *root.*

No bones were *used* in *manuring* the fields in Londonderry.

In *England* these *larvæ* are *well known,* but have never affected the crops.

In the department of the *Oise,* in France, they have *destroyed* the *Red-beet.*

The beginning and middle of *July* they change to *pupæ,* and *hatch* towards *end* of the month.

Possibly *more species* than one may have the *same habits,* as the larvæ vary in form, or this may be a *sexual distinction.*

Are the *eggs laid* in the *earth?*

They probably *hatch* the end of *May* or beginning of *June*.

Neither *salt* nor *lime* seemed to have the slightest *effect* upon the *larvæ*.

Sea-weeds and *dead animals* distributed in a field might *decoy them*, when they could be *destroyed* more readily.

The *parent beetles* can *fly*, but the *larvæ* are *bred in the field*.

Were the *eggs* introduced with the *seed?*

Seed should be *steeped in brine* or subjected to *heat* before sowing, to ascertain if either would free the crop from the larvæ.

Examine the *seeds* of an *infected crop*, to learn if the *eggs* be amongst them.

Search for the *beetles after July* upon the *stems running to seed*.

From the healthy state of plants accidentally left in the field where the crop was eaten off, it seems possible the *plants* may *recover* from the *attacks* of the *larvæ*.

Larva of a Shield-beetle, called *Cassida nebulosa*, feeds upon *leaves* of *mangold-wurzel*.

They reside *under the leaves*, and also live upon *Chenopodium hybridum* in *July*.

The *Shield-beetles hatch* the beginning of *August*.

A minute *parasitic fly*, one of the *Chalcidites*, inoculates the larvæ with its eggs, which hatch and *feed* upon the *fat*, &c. of the victim.

The Turnip-beetle, *Altica nemorum*, is now found to feed upon the leaves of the *mangold-wurzel* as well as on the turnip.

Larvæ of flies greatly resembling each other are often exceedingly *different* in their *economy*.

Maggots of *Anthomyia Betæ* discovered feeding on the *parenchyma* or pulp in *blistered leaves* of mangold-wurzel and sugar-beet, the end of June.

The *flies hatched* the third week in *July*.

The *maggots* may be *destroyed* by merely *pinching* the *blisters* visible on the leaves.

They change to brown *pupæ* in the *blistered* leaves.

If the *maggots* do *no harm* to *cattle* when the leaves are used for green food, *little mischief* is likely to arise from their *presence*.

Larva of the Crane-fly, *Tipula oleracea*, is a most *destructive* maggot in the *mangold-wurzel* field, carrying off entire crops by eating through the young *roots*.

Not safe to sow mangold-wurzel on fresh broken-up *pasture-land*, without *paring and burning*, salting, or liming the soil.

Rotten places and holes eaten by slugs in the roots of mangold-wurzel are *inhabited* by swarms of *insects*, and amongst them are large broods of a little beetle called *Cercyon boletophagum*, and an Acarus, *Uropoda umbilica*.

EXPLANATION OF PLATE S.

Fig. 1. Shoot of a bean as eaten by *Curculio* (*Otiorhynchus*) *picipes.*
a. Portions of excrement deposited by the weevils.
Fig. 2. A female weevil in repose.
Fig. 3.* A male walking.
b. The natural length.
Fig. 4.* One of the mandibles, or jaws.
Fig. 5.* One of the maxillæ, or second pair of jaws.
c. The palpus, or feeler.
Fig. 6.* Labium, or lower lip.
d. Palpi, or feelers.
Fig. 7. Larva or maggot, dead and shrivelled.
Fig. 8.* The same magnified.
Fig. 9. Under side of pupa.
Fig. 10.* The same magnified.
Fig. 11.* *Cerceris arenaria* flying; a little larger than life.
Fig. 12. A young mangold-wurzel plant, eaten by the larva of a Silpha.
Fig. 13. The young larva feeding.
Fig. 14. The larva nearly full grown.
Fig. 15.* One of the larvæ.
e The natural length.
Fig. 16.* Another of the larvæ.
f. The natural length.
Fig. 17.* One of the mandibles of the larvæ, the inner lobe shining through.
Fig. 18.* The inner lobe detached.
Fig. 19.* The maxilla.
g. The palpus, or feeler.
Fig. 20.* The mentum, or chin.
h. The labium, or lip.
i i. The palpi, or feelers.
Fig. 21.* One of the horns, or antennæ.
Fig. 22.* A leg detached.
Fig. 23. A male of *Silpha opaca*, running; scarcely larger than life.
Fig. 24.* The female magnified, and represented flying.
Fig. 25. Larva of the shield-beetle.
Fig. 26. Pupa of the same.
Fig. 27.* *Cassida nebulosa*, the beet shield-beetle.
k. The natural length.

Obs.—Those numbers with a * attached refer to the objects which are represented larger than life. All the figures are drawn from nature, excepting figures 25 and 26, which are copied from De Geer.

Hayes, near Uxbridge, Oct., 1847.

Errata in the last Report, Vol. VII., p. 405, *line* 20.

The paragraph ought to have been thus worded:—There were, however, both gardeners and farmers (uniting a close attention to the operations of nature with steady perseverance) who eventually succeeded in detecting the real cause of the mischief.

Plate R, fig. 21, exhibits the *pupa* of the bean aphis.

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XVI.—*On a New Mode of preparing Bones for Manure.* By PH. PUSEY, M.P.

HAVING succeeded in discovering a simple process for the cheaper use of bones as manure, I beg to state shortly the grounds which led me to the inquiry, and the proofs of its success.

In a few pages of this Journal, on the use of bones and sulphuric acid, I mentioned (two years since) that, if bones and moist peat-ashes are thrown in a heap together, the mixture heats violently, and the bones in a few days almost disappear, while their strength as manure is found to have greatly increased. This effect I ascribed to sulphuric acid contained in the peat-ashes; but it was a mistake, for the mixture, when examined chemically by Dr. Hofman, showed little or no sulphuric acid; and that Professor suggested that the decomposition must arise, as in many animal and vegetable substances, according to Baron Liebig, from the presence of moisture.

This hint was the more encouraging, because, if peat-ashes were not a necessary ingredient of the process it would be no longer confined to those farmers, a small number comparatively, who have peat-ashes at command. I therefore procured three cart-loads of crushed bones, and, having wetted them, mixed one cart-load with two loads of peat-ashes, another with two loads of coal-ashes, and the third load of bones with two loads of sterile white sand, dug up from some depth, and quite unfit in itself to support vegetation. The three heaps were made up as compactly as possible side by side. In a few days they all heated equally, becoming too hot in the middle to be borne by the naked hand; in a few more the bones had disappeared in each heap equally, being reduced in general to a blue mouldy substance. Some corroded fragments, indeed, remained in the centres; and the outsides, to the depth of five or six inches, were unchanged, because there the heat was insufficient.

The experiment having so far succeeded, the next step, of course, was to try the effects of the dissolved bones on the land, and in May, 1846, they were used upon half-acre lots of early turnips in equal proportions; the crops produced by each mixture were equally good. But as a single experiment does not, I think, justify one in putting forth the recommendation of a new practice, I waited for the result of another year's trial, which I will now lay before the Society.

It was made in July of the present year with common turnips. The object was to test the new preparation by comparing it, on the one hand, with unprepared bones, and, on the other, with bones dissolved by sulphuric acid, called *superphosphate*.

The land is a hot stonebrash newly taken in hand and very

much out of heart. Bones act upon it very strongly; for the trial-lots are part of 70 acres of turnips and swedes, a good crop produced by superphosphate, notwithstanding the drought; but wherever that preparation was purposely missed, the yield was not more than four, or at most five, tons to the acre.

The trial was made on the supposition that certain quantities of each manure were likely to yield equal produce; and it was proposed to test the difference, not of produce from the same cost of manure, but of cost for nearly the same amount of produce. The mixture was made in this case by throwing together a waggon-load of crushed bones wetted, and, by a mistake of the workmen, half that quantity only of sand. The heap, however, heated violently, and was in a few days fit for use. Three bushels of the mixture are valued higher than two bushels of bones, because the heap sank during the process one foot in four, showing, as I had suspected, that, from the shrinking of the bones, there would be more than two bushels of bones in three of the mixture.

First Experiment.

Bushels of Manure per Acre.	Cost of Manure per Acre. £	s.	d.	Produce per Acre. Tons.	cwts.
1. 17 bones . . .	2	6	9	13	5
2. 4¼ sulphated bones . .	1	2	9	14	5
3. 8½ heated bones and sand .	1	0	9	13	5

The amount of produce was nearly equal, as I had hoped it might be, and both preparations show a large saving as against unprepared bones. In another experiment a larger quantity of each manure was applied with the following result:—

Bushels of Manure per Acre.	Cost of Manure per Acre. £	s.	d.	Produce per Acre. Tons.	cwts.
4. 25½ bones . . .	3	10	0	14	5
5. 7½ sulphated bones . .	2	3	0	14	5
6. 12¾ heated bones and sand .	1	11	0	17	1

On the three last lots it will be seen the manures were applied, each at the rate of about half as much again as on the first three lots. The reason was this. I proved in a former Journal, by a careful experiment devised for the purpose, that some manures, when applied in increased quantity, do not produce a corresponding increase of crop—have in fact a limit beyond which it is vain to apply them. This view, having since been confirmed by the experience of others, may now be regarded as founded in the laws of vegetation. It is also strikingly confirmed here, for, by increasing the dose of sulphated bones rather more than one half, we get no increase of turnips: and by increasing the rough bones one half, while swelling the expense from 46*s.* to 70*s.*, we get no

increase worth speaking of. It would be a fallacy, therefore, to compare different manures without knowing whether each had been used to the proper extent and no further; and this is the exaggeration which I wished to avoid.

The result of the whole seems to recommend decidedly the mode of preparing bones which I propose, and, but for the mistake of my men in mixing so small a proportion of sand, I believe the effect would have been stronger. Practically I think that the manuring virtue of bones is increased from three to four fold by this simple process, which cannot be said to cost anything. It is within reach of every one to practise on a large scale and at a few days' notice. Though I mixed barren sand with the bones for the sake of experiment, any light loam would no doubt answer as well or better—the soil itself, in fact, of any farm where bones themselves are likely to answer; and the labour is so trifling that it is not worth speaking of.

The quantity of bones applied should be between 5 bushels and 8 bushels per acre. Bones prepared in this way do not produce at first so lively an effect on the young plants as bones prepared with sulphuric acid. Thus, in this trial, lot 6 looked for many weeks worse than its neighbours, yet in solid food that lot has turned out the best of the whole.

This mode of preparation has been tried, at my suggestion, by a neighbouring farmer, Mr. Edmonds, who mixed up 80 bushels of bones with sand in a single heap of a circular form, and, having applied them at the rate of 8 bushels per acre, tells me that he shall henceforth use bones in no other manner. This is no doubt the right shape for a heap, because the exterior being cool will always remain unchanged, though this defect might be removed by a covering of earth. Some bulk of bones is necessary, I think, to produce the heat, and the bones, as well as the material mixed with them, should be moistened if dry.

Another farmer, Mr. Davy, who tried the mixture of bones with ashes at my suggestion, informs me that 16 bushels of unprepared bones, 4 bushels of heated bones, and 2 bushels of sulphated bones, or superphosphate, gave each the same yield of swedes. The principle at work is evidently Putrefaction taking place in the gelatinous substance of the bone; but no disgusting smell is produced, merely a strong odour of ammonia when the heap is opened. Most of this ammonia is probably drilled into the land—an advantage over the process of dissolving bones in acid, which seems to drive the ammonia away.

In proposing this simple method I do not mean that other ingredients may not be mixed up advantageously, if experience should prove their necessity. But this is less likely, as the whole doctrine of manuring plants with the ingredients of their ashes is

rendered very doubtful by Mr. Lawes's careful experiments. In any case, however, the process now proposed will be equally applicable. Since this inquiry was begun, I find it mentioned by Baron Liebig that moistened bones generate heat and enter into putrefaction. The application of this principle is what I now feel warranted, after two years' careful trial, to recommend to the notice of English farmers. It is the same principle as, when carried to excess, shows itself in the formidable shape of spontaneous combustion; but I entertain the hope that this law of nature, which has hitherto only been known to us by setting fire to our ricks, or kindling the cargoes of ships, may at last become a willing handmaid in enriching our fields.

Pusey, Nov. 7, 1847. PH. PUSEY.

XVII.—*Trial of Seedling Potatoes.* By W. MILES.

To Mr. Pusey.

MY DEAR PUSEY,—You may recollect that early in March this year some potato-seed was distributed amongst the Members of the Council: to my lot fell about half a table-spoon of seed and charcoal mixed, which I immediately sent down to my gardener, with instructions to him to do the best he could to procure the greatest number of plants, and the largest quantity of potatoes from each plant, so as to ensure a stock of tubers from seedling plants, the parents of which had appeared to have been in no-wise infected by the prevalent disease. The following is the report sent in to me from my gardener:—

On March 15th the seed was sown in a shallow box about 4 inches deep, and placed in an early vinery; as the plants came up they were kept pricked off three in a large 60-sized pot, and still kept in the vinery until the plants were about 3 inches high, when they were potted off singly into 48-sized pots, and put into a green-house, where they remained until the 15th of May, when they were planted in the open ground, at 2 feet distance from plant to plant in the row, and 3 feet from row to row. In planting the plants were turned out of the pots with the balls entire, placed on the surface of the ground at the above distance, and the earth then drawn to the plants, leaving only two joints or leaves above the surface, after which they were well watered with a rose-pot to settle the earth round the plants. About the middle of June the roots were found appearing very strong on the surface, when 3 inches more earth was added to them, the same system being continued as often as the roots appeared on the surface. On the 5th of August six of the weakest plants were observed ripening off, and were taken up; the others remained in the ground

until the 15th of September. The following tables show the produce of both kinds :—

Potatoes taken up August 5th.

No.	Quantity of Potatoes.	Total Weight.		Sorts.	Number of diseased Potatoes.
		lb.	oz.		
1	7	1	0	Kidney	0
2	13	1	0	Ditto	0
3	17	0	12	Round	0
4	19	0	4	Ditto	0
5	12	0	4	Kidney	0
6	14	0	4½	Ditto	0

No disease whatever appeared in these early sorts.

Potatoes taken up September 15th.

No.	Quantity of Potatoes.	Total Weight.		Sorts.	Number of diseased Potatoes.
		lbs.	oz.		
1	260	6	12	Round	20
2	192	6	8	Ditto	12
3	160	3	12	Round red	3
4	80	3	12	Ditto	0
5	60	3	9	Kidney	0
6	80	3	7	Ditto	8
7	50	2	12	Round	14
8	37	2	0	Kidney	0
9	43	1	14	Ditto	0
10	60	1	13	Ditto	1
11	25	1	7	Round	0
12	55	1	6	Ditto	0
13	36	1	4	Ditto	0
14	36	1	1	Ditto	1
15	21	0	11	Ditto	0

The actual weight of tubers thus raised from 21 seeds was 44 lbs. 8½ oz., discarding all fractions, say upon an average 2 lbs. of healthy tubers to each plant. The number of plants thus raised per acre would be 7260, which multiplied by 2, the average weight of the produce of each of the plants will give 14,520 lbs. = 6 tons 9 cwt. an acre, or taking the sack at 2½ cwt. to 51½ sacks per acre.

The result of this experiment is extraordinary from the weight as well as the size of some of the tubers produced from these seedling plants: the course of disease seems to have affected the produce from untainted stock precisely in the same manner as the field crops: for here the early sorts were entirely sound; but, from the appearance of those I am now digging, the late sorts are considerably affected. In the case of the seedlings planted contiguous to each other, about one-half were more or less affected, whilst the remainder wholly escaped infection: and it will be well worth while hereafter, should the disease continue, to mark whether the untainted seedlings show as a crop the same capability of withstanding the disease.

W. Miles.

Leigh Court, 11th Oct. 1847.

XVIII.—*On the Agriculture of Northumberland.* By Thomas L. Colbeck.

Prize Report.

Situation and Climate.—Owing to the situation which this county occupies between the German Ocean, and the hills of Scotland and Cumberland, the weather is subject to great and sudden changes, causing difficulties and hindrances to the farmer, unknown in the southern and midland counties of England.

Description of Surface.—The west part of the county consists of bold hills, ranging from 800 to nearly 2000 feet in height, and affords excellent pasturage to the hardy sheep of the district. Although this part is mostly unenclosed and unimproved by attention of any kind, great numbers of sheep are yearly brought from it into the other parts of the county for fattening.

Description of Soil.—Adjoining these hills, and especially if the subsoil be porous, there are some superior grazing farms. Generally speaking, the centre and south-east of the county consist of a poor, wet, heavy soil, producing, comparatively, inferior crops of corn, unless within the reach of manure. The grassland of this district is employed in rearing short-horned cattle. At some points along the coast a very superior wheat soil is found; but at present by far the most valuable land to the farmer is the turnip district on the banks of the Tweed, Aln, Coquet, and Tyne.

Size and Tenure of Estates.—In this county there are estates of every value between the smallest *lairdship* and the princely domains of the Duke of Northumberland, Earl Grey, and others; and, with few exceptions, the tenure is freehold.

Tenure of Farms.—Although the advantages of long leases are

yearly becoming more understood, a great proportion of the farms in this county are still let from year to year. It will indeed seem strange, that so absurd a custom should be persisted in, when the ruinous consequences are so apparent.

The usual form of lease, although slightly varying from local causes, has nothing in it peculiar to the district. The time of entry is generally the 12th of May; the tenant paying no rent until one year in possession, and allowing his predecessor the crop from one half of the land, with the use of barn and stack-yard, for one year after he has left. Upon the estates of the Duke of Northumberland, and a few other landowners, the term of entry is the 25th of March, the entering tenant obtaining possession of the whole crop by paying the previous tenant, for seed and labour. It is difficult to say which of these methods is the best, as the best practical men are divided on the subject. In general the owner repairs all outbuildings, the tenants being expected to cart the materials for any new erections required. Few of the tillage farms exceed 1000 acres, and in the neighbourhood of Newcastle there are many not more than 100 acres. The grazing farms are much larger, many adjoining the Cheviot Hills being very extensive.

Annual Value of the Land.—The figures on the accompanying map will supply every information respecting the value of the land in this county, better than a written description could have done.

Draining, &c.—Draining has been carried to a great extent within the last few years. Some landowners charging 5 per cent. on the entire cost, and others supplying the tiles, and the tenant executing the drains. Instances are, however, by no means rare, when long leases are granted, of the tenant executing the whole at his own expense.

Farm-Buildings, &c.—There has been a gradual improvement of late years in the farm-buildings of this county. Those erected by the Commissioners of Greenwich Hospital, under the direction of J. Grey, Esq., of Dilston, contain every convenience a farmer could desire. There are also many farm-buildings in the north of the county, which cannot be exceeded.

Tithes.—The late Tithe Act has happily removed many just causes of complaint.

Poor-rates.—The poor-rates in the agricultural districts of the county are very moderate, relief to able-bodied men being unknown. At the time the New Poor Law came into operation, some of the unions were highly complimented by the Commissioners, for the contrast they afforded in this respect to the degrading practice of the southern counties.

Highway-rates.—The highway-rates are moderate, and seldom a serious burden to the farmer.

2 F 2

Implements, &c.—The implements in use in this county are of the most improved description. The light single-horse cart is gradually replacing the old heavy waggons and carts; and the Scotch swing-plough, drawn by two horses abreast, certainly looks neater, and produces as good work in the hands of ordinary workmen as any of the south-country *wheeled* ploughs. The great disadvantage, attending many of the excellent implements shown at the agricultural meetings, is their great complexity and consequent high price. These two circumstances unfortunately place many of them out of the reach of the ordinary class of farmers. Many of the seed and manure drills, Crossgill's patent clod-crusher, and others of the same description, are thus unfortunately prevented from coming into general use.

There are now few farms without a thrashing-machine; and the steam-engine, as applied to it, is one of the most striking additions to the improved farm-buildings already named. Where the farm is large it is a great acquisition. Grant's patent horse-rake is yearly becoming more generally used—a sure proof of its value. The writer has used a large one of the same pattern for several years, and finds it very useful in hay-harvest. Two men and one horse will sweep together from 12 to 14 acres of hay per day with it. The Hainault scythe for corn-harvest, has been lately introduced, and is found to be a valuable acquisition.

As the turnip season is one of great consequence in the district, the most improved turnip-drills are eagerly sought after. The above seem to be the only farm-implements in use in the district, which require special notice.

Description of Farming.—The systems of farming, in this extensive county, are as various as the soils and situations already mentioned, but they may be described under three heads—

A. On Wheat Soil;

B. On Barley or Turnip Soil; and

C. On Stock or Grazing Farms;—

Of which I shall now proceed to treat in detail.

A. *On Wheat Soils*—which have been described as generally occupying the middle and south-east of the county, the four-course system is universally in use, namely:—1st year, fallow; 2nd year, wheat; 3rd year, clover or beans; 4th year, oats. The improvement recently effected by draining, even on the most stubborn wheat soils, has led to some variation in this system of cropping. The usual practice is to allot from 12 to 15 acres of fallow to each pair of horses, and of these about 3 to 5 acres are in potatoes or turnips, which will make the rotation as follows. Suppose a farm of 60 acres, of these—

1. Fallow . . .	10		
Potatoes or turnips	5		
	—	. .	15 acres.
2. Wheat . . .	10		
Barley . . .	5		
	—	. .	15 ,,
3. Clover, beans, or peas .		. .	15 ,,
4. Oats		. .	15 ,,
			60 acres.

1. It is scarcely necessary to point out the advantage, of being able to add turnips to this rotation, and since the value of guano as a manure for this root was fully known, there seems to be no limit to its production; thus furnishing the farmer with an increased quantity of farm-yard dung for his corn-crops, on which the guano has a much less certain effect than on the turnip-crop. The land, intended for turnips, is ploughed immediately after harvest, and as soon as it is sufficiently dry in the spring it receives one furrow across the ridges; and afterwards, until sufficiently reduced, three or four ploughings in the direction of the intended turnip-drills. When a sufficient quantity of farm-yard dung can be procured, it is sometimes spread on the level surface; and drills about 28 in. wide raised with the ordinary plough. More commonly the drills are raised, and the manure deposited in small heaps for every three drills. After being spread on by women and children, the dung is covered by a *double* mouldboard plough, *reversing* or *splitting* the drills, and the land is ready for the seed. During its growth the crop receives the usual attention of horse and hand hoeing, and finally furrowing up so as to lie dry during the winter. Of late years several different varieties of turnips have been introduced, but at present the favourites seem to be the swede, hybrid, and border imperial for winter storing; and for early use none can be more suitable than the common white globe.

2. After the turnips are sown, the remainder of the fallow receives four or five ploughings during the summer; the manure or lime being laid on and covered in by the last ploughing but one, which is, if possible, done before harvest. The quantity of manure varies with the *situation* of the farm, and the means of the farmer, between 15 and 30 loads per acre. As in turnips, so in wheat, several different varieties have lately been introduced. Few of them have however withstood the test of experience; it being found that the fine wheats from the south of England are apt to become coarse and unproductive when sown in this county. Sparling's Prolific, and a few others, are deservedly favourites. As the names of the new wheats are mostly local, a mere list of them could convey little information. This grain is usually sown broad-

cast at the rate of 2 bushels per acre. From carefully conducted experiments the writer is of opinion that the crop is generally as productive by this method as when sown by the drill, the only gain being about a quarter of a bushel of seed per acre, unless the land be intended for after-cultivation, when the drill is indispensable. Previous to sowing, the wheat is always carefully steeped in chamber-lye and dried with quicklime, which is found to be a complete safeguard against *smut*. In wet cold springs this crop is sometimes seriously injured by *rust*. Draining seems to be the only remedy for this disease.

Lime, when it can be procured, is found to be of great value on the land we are describing. Unfortunately throughout the district, it is found in such small quantities as to render it impossible for the farmer to obtain sufficient of it, to produce the full benefit of its chemical and mechanical action, on the retentive clays of the middle of the county. Should any of the proposed railways be the means of placing this substance within the farmer's reach, it would be a valuable boon.

3. The artificial grasses mostly cultivated in this rotation are common broad clover, white clover, cow-grass *(trifolium medium)*, hop clover, rye-grass, annual and perennial, and sometimes the Italian rye-grass. They are sown upon the wheat or barley as early as possible in the spring. Of all the crops which the farmer cultivates, there are none which he finds so unmanageable as the red clover; and, next to the improvement effected by the culture of turnips, the most valuable is that produced by the bean and pea. It is found that after clover has been cultivated a number of years, on the same ground, it at length fails altogether; nor can any after-cultivation or cropping, except the bean, restore the land to its original fertility. The general plan is to sow one half, or at least one-third, of the wheat-stubble with beans or peas, so that the same land is only in clover once in eight years, or twice in twelve. The only preparation the land receives for beans, is one furrow early in winter, and about 4 bushels per acre is the usual quantity of seed. The drill is universally used for this crop, horse and hand hoeing being indispensable. The produce varies very much; about 20 bushels per acre will be near the average.

In the neighbourhood of Warkworth and some other parts of the county, whilst the soil is sufficiently strong to bear excellent crops of wheat, the subsoil is dry enough to be worked early in the spring. It is the practice in that neighbourhood, to drill up the land intended for beans in the same way as done for turnips—a most admirable practice, as it allows the free application of the horse-hoe, and leaves the ground in as perfect a state as can be desired for after-cropping.

Cow-grass and Italian rye-grass have only lately been introduced. The former is found to be exceedingly valuable, as it will grow on land which is tired of broad clover, though it does not produce a good aftermath.

The common vetch grows very well on the wheat stubble, and is used as green food for the farm cattle.

The hay-harvest is slower than in the south of England, as the weather is more changeable and liable to frequent showers. The swathes are not broken up until the hay is sufficiently dry to keep in small temporary stacks containing 1 or 2 cart-loads, in which it is allowed to remain until in a fit state for the large stacks.

On the description of land now under consideration, neither turnips, tares, nor clover are consumed on the ground; they are either made into hay or eaten by the stock in the farm-yards or stables.

4. The Tartar, Hopetown, and Potato oats are all cultivated in this district. On the high land adjoining the sheep pastures, at the west side of the county, oats are sometimes sown, after turnips or fallow, it being found that they will ripen when wheat cannot be profitably cultivated. With this exception, they are sown after beans, peas, or clover.

When the rotation that we are describing is followed, there is not much stock kept, the permanent grass, of which every farm has a proportion, being either made into hay or employed in rearing young cattle. A tract of land near Stamfordham is, however, an exception to this remark, as the grass-land is of such good quality that considerable quantities of heavy stock are yearly turned off it, fat.

B. *Barley and Turnip Rotation.*—The low price of grain for the last few years has caused more attention to be paid to this system of farming than that which we have been describing. The part of the county where this rotation is mostly practised, has been already described, and, as it is in the hands of men of capital, presents a striking contrast in the style of management to the wheat-farming already alluded to. The farm-buildings are also erected in a style of elegance and convenience which will bear comparison with those of any part of the kingdom, perhaps of the world. The northern part of the county especially, has long been justly praised.

A dry porous subsoil is an *essential* requisite for this description of farming; where this is found, throughout the county the rotation is—

1. Turnips—2. Barley—3. Clover and grass seeds—4. Ditto ditto—5. Oats.

1. *Turnips.*—So much has the cultivation of this valuable root increased since the general use of bones and guano, that large

quantities are now sent by shipping to Newcastle from the northern part of the county. It is indeed impossible to over-estimate the value of these manures, their effect upon this crop being so certain. Before they came into general use, the only resource the farmer had was his farm-yard dung, which could only raise a sufficient quantity of food to keep the stock alive, instead of fattening them, as now, during the winter.

Early in February the bustle of preparation for turnip seed-time commences; the horses are worked with but little intermission from five in the morning until dark, so that each pair will put in about 17 acres during the season. The preparation of the land and after-culture of the turnip do not differ from that already described, except in the substitution of bones and guano for the farm-yard dung; they are now generally used mixed, at the rate of 4 cwt. per acre. No effectual remedy appears to have been discovered for the ravages of the fly or caterpillar. It is found that after the turnip has been cultivated a number of years on the same ground, it is attacked by what is here called "fingers and toes," which is caused by a small beetle. Lime is said to remedy this evil, but the only certain cure is either a bare fallow or a crop of potatoes instead of the turnips. The ground is seldom stripped entirely of the turnips, that being found too impoverishing. The usual practice is, to pull off every alternate 6 drills, for the use of the cattle in the folds, and to eat the remainder on with sheep; the dry character of the land rendering this easy, and more beneficial than any amount of manure that could be applied, for the after-crops.

2. The preparation of the land and after-culture of the barley do not differ from what has been already described. The Chevalier is usually grown, and, if it follows a good crop of turnips, will yield as far as 50 bushels per acre. Although this rotation is commonly called the *turnip and barley* system, it might with nearly equal propriety be called the *turnip and wheat*, as a most striking change has taken place of late in the extent to which wheat is grown on light soils, where its culture was formerly thought impossible. It is found, when the turnips are eaten on the land with sheep, abundant crops of wheat can be grown, if sown before February or even March.

3 and 4. As in the previous rotation, *clover* and *grass seeds* are sown upon the wheat or barley in the spring.* On all but the very richest land, the grass remains two years at least. It is gene-

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* On wheat soils, the following is the quantity sown:—Broad clover, 5 lbs.; hop clover, 1 lb.; and white, 1 lb.; with $\frac{1}{2}$ bushel of rye-grass per acre. On turnip-land the writer has been informed that the following never fails to produce a good crop:—Broad clover, 5 lbs.; white, 3 lbs.; hop, 2 lbs.; rib-grass, 2 lbs.; with 1 bushel of rye-grass.

rally mown the first year, and pastured the second. In the neighbouring county of Berwickshire the five-course system is universal, and permanent grass dispensed with altogether.

5. The oat-crop is managed precisely as in the previous rotation, although the better varieties are commonly grown, such as the Potato and Hopetown.

It must not be omitted to mention, that the pea takes the same place in this system of cropping that the bean does in that already described, and with equal advantage to the clover-crop.

The farms under this rotation are generally on long leases, thus giving proper security to the spirited farmer, who rarely fails to benefit both himself and landlord by the use of costly artificial manures, and by feeding his cattle with oil-cake. Lime is also frequently carted a distance of forty miles, and found to repay this great expense. Whatever may be said by interested parties against the farmers as a class (sometimes with too much truth), *here* it is undeserved. We have no hesitation in saying, that a more enterprising body of men does not exist than those who farm in the district we have been describing.

Though the potato is not so extensively cultivated as the turnip in this county, it deserves some notice, forming as it does so serious an item in the food of all classes. The supply for the wants of the county is, in a great measure, drawn by railway from Cumberland, and by shipping from Scotland. This root requires a rather stronger soil than turnips, and is here cultivated in precisely a similar manner in drills, the lazy-bed system of the southern counties being unknown. If the statements of the old farmers are to be relied on, there is a yearly increasing difficulty in securing a good crop of potatoes, so much so, that the kidney potato, formerly the universal favourite, has long ceased to be a profitable crop. Experiments of every kind have been tried in the county to prevent the ravages of the *disease,* but hitherto without success. Notwithstanding all that has been said and written on this important subject, we feel ourselves compelled to agree with a speaker at the late meeting of the British Association, that we literally know nothing about either the cause or the remedy of the potato disease.

C. In describing the stock, and system of stock-feeding in Northumberland, the writer thinks he will be best understood by dividing the subject into three heads:—1. *On the Hill or Breeding Farms;* 2. *On the Turnip Farms;* and 3. *On the Grazing Farms, with Turnips.*

1. *On the Hill or Breeding Farms.*—A great portion of the western and north-western parts of Northumberland, as already named, are solely adapted for sheep pasturage, and the Cheviot breed is mainly if not altogether kept. The farms in this district

are strictly breeding farms. The usual practice is to cast the spare stock at May and October, but principally in the autumn. It is only off farms which will not keep their wethers until 2½ years old, that a cast of hogs and dinmonts takes place in the month of May, or that a very prosperous lambing season has thrown the tenants into a larger stock, than the farm may be safely trusted to keep, on account of eating the ground too bare and rotting the stock, which misfortune, however, does not now so often happen since more attention has been paid to draining. The ewes are cast in October, at five or six years old, and generally sold to farmers occupying the lower and better land of Northumberland, where they are fed the same season, the more backward ones receiving a few turnips. The tups are put to the ewes on or about November 22, and have their first lambs at three years old. The lambs are taken from their mothers in June, and generally sent away for a month to be *spained,* or weaned. It is a received opinion among stockmasters, that the harder lambs are kept during the weaning month the healthier they become. Places, having a great proportion of black heather, to which the lambs are sent for a month, are carefully selected so as to get them well *birned,* or hardened. But as many as four or five to the score of young hogs are sometimes lost by *sickness,*—though this has also been much remedied by greater attention to draining. The young wethers, as they are called, are cast at the same time, and sold at the same fairs as the other sheep. Those in good condition, and off the best farms, are bought for turniping—the inferior ones are wintered again, without turnips, and fattened the next summer. The latter usually come into the market in September.

A great improvement has taken place in the breed of this class of stock within the last few years. A keen and praiseworthy competition now exists amongst the stockmasters as to who can produce the best stock, for which local shows have been established in Reidwater and North Tyne. The Messrs. Robson, of Keildor, seem to have taken the lead as breeders of this stock, having been the most successful competitors.

The first and principal improvements to be made upon hill farms are draining and planting, and much judgment should be exercised in so laying out a plantation as to throw shelter over the largest quantity of ground. It is a fault too commonly committed in making shelter for sheep upon hill farms, to plant small enclosures. These certainly give shelter in a stormy night, but in a continuance of severe weather they do more harm than good, by inducing the sheep to run to shelter; whereas if large belts of plantations, stretching along rising ground, were made, they would give shelter to the lower ground for miles in hard weather; and the sheep would get out to feed. It is in keen nipping weather,

when the wind is high, that sheep run most to shelter, and lose their condition, which might be greatly avoided by judicious planting.

2. *On Turnip Farms.*—As already named, the great object with the farmers in the north and north-eastern part of Northumberland, is to raise as many turnips as possible, one half of which are usually consumed on the land by sheep, and the other half drawn off to feed the cattle in the folds.

On the farms between Wooler and the Tweed, which are all on the five-course system, a breeding stock of pure Leicester sheep is generally kept, and great competition now exists who can produce the finest stock. The ewes are drafted off for sale in September, at four years old. In the year 1846 from 46*s.* to 48*s.* per head was obtained for the primest lots, but on an average of years from 30*s.* to 40*s.* is the usual price. They generally have their first lambs at two years old. On farms where larger breadths of turnips are sown, the Wedder lambs are netted upon them in October, and full fed. The swede turnips are invariably cut for them. This is quite necessary, as full-fed hogs shed their teeth in February, which prevents them from breaking the hard turnips. They are generally brought into the market, after being shorn, in May and June, and vary in weight between 15 lbs. and 18 lbs. per quarter. But if, as is often done, they receive corn and oil-cake, they are often 20 lbs. per quarter. The ewe lambs not required to keep up the breeding stock are marked out in the autumn, and, although well fed, are scarcely so highly treated as the others. Besides the sheep, the tenants occupying such farms as we are now describing rear a good many calves, mostly contriving to bring up three for each cow during the winter and spring. These are grazed on the new grass, and kept till one year and a half old, after which they are fed fat with full turnips in the yard, and will bring at two years as much as 15*l.* to 18*l.* The extra cattle, required to consume the turnips, are purchased at the district fairs, or from south-country dealers. It is necessary to pay great attention to the feeding cattle, to see that they are kept clean, and get their meat at different times of the day; keeping them clean and warm being, in the words of a respectable farmer, "as good as half meat."

On the turnip farms to which a stretch of hill land is attached, such as some west of Wooler, two kinds of stock are kept—on the low lands the Leicesters, and on the hills the Cheviots. In order to keep up their Cheviot stock, many farmers breed from the young ewes to a Cheviot tup, and in the last year or years, from the ewes they are going to cast, they commonly take a cross of lambs by a Leicester tup: the lambs by this *parentage* are called *half-breds.* They are generally half-turniped in winter, that is,

they are kept on the turnips till mid-day, and then allowed to make out to the hills in the afterpart of the day. The ewe hogs are generally fed off grass the following summer, and sold fat. The wethers are grazed, and either sold in October, to feed on turnips, or kept and fed by the breeder. When it is not intended to feed hogs off turnips, but to graze them the following summer, it is best to allow them to come to turnips as soon as they come from their lair in the morning, and to make off into rough land in the afternoon, as by this means they get to more bone and grow to a larger size, and produce the finest quality of mutton. The sheep also get fuller in the loins by being more gradually fed. The variety of food has also the good effect of keeping the sheep in health. However simple the above fact may seem at first sight, it is found to be of first-rate importance by men of experience; where no such heathy ground is at the farmer's command, it is always advisable to give the sheep hay or pea-straw, as either has the effect of making them relish the turnips, and keeps their teeth clean.

The Leicester and Cheviot sheep are both exceedingly well adapted to the situations in which they are kept and the treatment they commonly receive. The Leicesters only do well on low, dry, warm, and level lands; being of a quiet, domestic, and inactive nature, they should procure their meat easily, and have a great deal of rest during the day. The Cheviot sheep, on the contrary, are of a sprightly, wild, active nature, and lightly made. They take little rest during the day, and wide ranges to seek their food, which circumstances recommend them above every other breed to the Northumberland hill farmer. The Cheviot sheep are superior to the Highland black-faced sheep, as they are not so wild as the latter, and come earlier to maturity.

As sheep for grazing purposes, there are none equal to the *half-breds*, already named, especially if intended to be fed off grass of second quality, without having had good treatment the previous winter. They perhaps do not fatten so readily at an early age as the Leicester sheep, but were they to receive as good treatment from their birth, and kept to two years old, they would make as heavy sheep, and worth more by the pound. They possess in a medium degree, when fat, the best points of the Leicester and Cheviot sheep. Both these breeds are spotty in their points when fat; the former may be considered prime when they have fat ribs, loins, and good breasts, without being fat on their tail-heads, and with small neck-veins and legs; the latter may be said to be prime, with fat tail-heads, good neck-veins, loins, and legs, without being fat on their ribs and breasts. The half-bred sheep, when fat, possess all these good qualities in a happy medium, and justly deserve to be called the nicest muttoned sheep fed in

Northumberland. The excellence of a fat sheep does not consist in extreme fatness, but being full in his loin and fine points, such as neck, ribs, legs, &c. The half-bred are the most fashionable, and most liked by the butchers having the best retail trade. In summer they command a higher price by ½*d.* per lb. The Cheviot sheep fed off turnips from January to May, if good, will certainly command as good a price in the market as the half-bred, as the weather is then cold enough to admit of the mutton being kept until tender; besides, the loin looks so black in sunny weather, that it is not to be compared to that of the half-bred sheep. It is therefore the writer's decided opinion, where the situation is suitable, that the half-bred sheep are the finest, and most profitable to the farmer, especially for feeding off grass. They are also longer in their shapes and quarters than the Leicester sheep, which advantage they derive from the Cheviots. This confirms the writer in his opinion, that after coming to a certain age they would get heavier sheep. For full feeding and early maturity there are no sheep equal to the Leicester, but the mutton is not so good in quality, and without flavour; consequently, it does not bring so high a price; and what still contributes to make the half-bred the more valuable is, that their wool is worth from 1½*d.* to 2*d.* per lb. more.

3. *On Grazing Farms with Turnips.*—It will be perceived that, in the previous article, the writer has anticipated his subject, as far as sheep are concerned: nothing now remains but to describe the system followed in grazing and feeding cattle.

The quality of the land, of course, decides the kind of stock purchased for it. We feed, upon all land that will graze fat, from a Durham ox to a Kyloe heifer. If the land be of first-rate quality, of course the Durham ox is preferred, as he will grow more than any other description of stock fed in Northumberland, and possesses a greater aptitude to fatten. In selecting feeding-stock, it should always be kept in mind to choose such as are likely to grow in size, and at the same time have a disposition to feed; which two important qualities the Durham ox seems to possess to a greater extent than any other breed, and is therefore most profitable to the farmer on good land. Heifers of this breed will graze upon land of an inferior quality from that required by oxen: they also feed faster, though they do not grow so fast. Next to the Durhams, the most profitable stock fed in the county is the Argyleshire heifer. An ox or *stot* of this breed requires as good land as the Durhams to feed on; and sometimes they will make as much profit, as they are highly prized by the butchers who have a good retail trade, on account of their cutting out so well in their fine points, and having so little coarse beef about them. They are generally one, and sometimes two years older than the Durhams, when put up to feed, and, of course, do not

grow so well as the latter; which induces the writer to give them the preference to the Argyleshire cattle. The Durhams feed best at three years old, and the Argyles at four. A heifer of this breed will feed on much inferior land to that required by a Durham heifer: while the latter requires land worth 30*s.* per acre, the former will do well on land from 12*s.* to 20*s.* per acre. One other striking difference between the two breeds is, that the Argyles swell more out, but do not grow so much as the Durhams. There is, however, no class of stock sells better than the Argyles between September and Christmas, if between 34 and 40 stones weight. The grazing of this class of stock has much increased within the last few years in Northumberland; and, now that travelling is so easy, most of the extensive farmers attend the large Scotch trysts in the autumn, where they purchase heifers to graze on their inferior grass-land, which they suit better than any other description. The black-polled Angus-shire cattle have also lately been introduced into Northumberland. They are the principal breed of cattle in Fife, Perth, and Forfar, where stall-feeding is adopted, for which purpose they are preferred by the farmers in that district. Where attention has been paid to the breed, these are found to be excellent cattle, and have been brought to great perfection by Mr. Watson of Keillor, and some others. Of all the plans for fattening cattle, there seems to be none which possesses so many advantages as stall-feeding. Economy and *variety* in food, together with perfect cleanliness, can be secured by this means alone. The collection and saving of the liquid manure can be managed with ease and certainty, in vain to be expected in open folds. Although considerable attention has been directed to it lately, the writer is not aware that it has been adopted in Northumberland except for milk cows. When such expensive food as linseed, peas-meal, and crushed corn are used, unless the cattle are stall-fed, there is great waste. Although these articles named may seem too expensive for cattle, yet the improvement which always follows a *variety* of food, as well as the increased value of the manure (particularly with linseed cake), is found to remunerate the farmer, as the cattle fatten more than when confined to one diet, such as turnips. And if food is thus judiciously given, *a less weight of nourishment will produce the same results as to weight of beef.* The Irish cattle are found to do very well on land of similar value to that required by the Argyle heifer, though much inferior in feeding qualities to the latter. The breed has been much improved by a judicious cross with the Durhams. They are most suitable for wintering in an open fold, when poor keep only can be procured, and do not answer so well as the Argyles, which do not require better land to feed on.

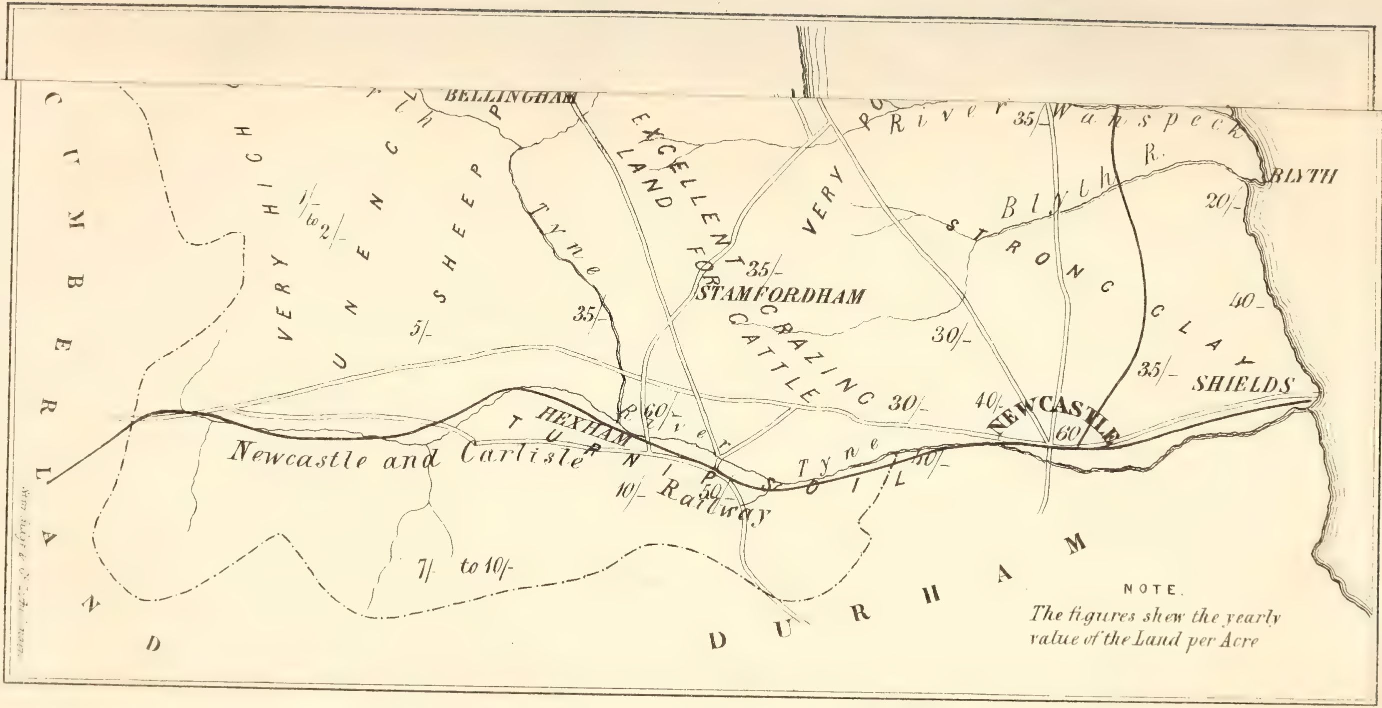
In concluding this brief notice of the stock-farming in Northumberland, the writer has found himself at a loss how to express himself sufficiently concisely, as scarcely two farmers can be found to agree in their plans and mode of procedure. The foregoing remarks will not, however, be found far from the truth as applied to any part of the county, though most applicable to the northern, as the most important cattle-feeding district.

Horses are not reared to the same extent in the county as formerly, in consequence of their decline in value for several years. Several of the wealthy proprietors have, however, their racing and hunting studs. Perhaps the most celebrated was that of the late Mr. Ord of Nunnykirk, the owner and breeder of the famous Beeswing. The farm-horses are generally light, clean legged, and active, at present worth about 35*l.* each, although a few years ago the same horse would scarcely have brought 20*l.* The old-fashioned plan of feeding farm-horses on hay is fast creeping into disuse, and the less expensive one of giving them straw, and boiled or crushed corn, during winter, and tares or other green food during summer, is fast gaining ground. Bean straw is the best of this description of food, the only precaution necessary during the time the horses are fed with it, is to supply them very regularly with turnips and boiled corn, as they are liable to inflammation and colic, if neglected. Along with the steam thrashing-machines already mentioned, it has become usual to attach a *corn-crushing mill,* which is said to save about one-fifth of the corn. Hay-cutters, although in use in gentlemen's stables, have not yet become general in the county.

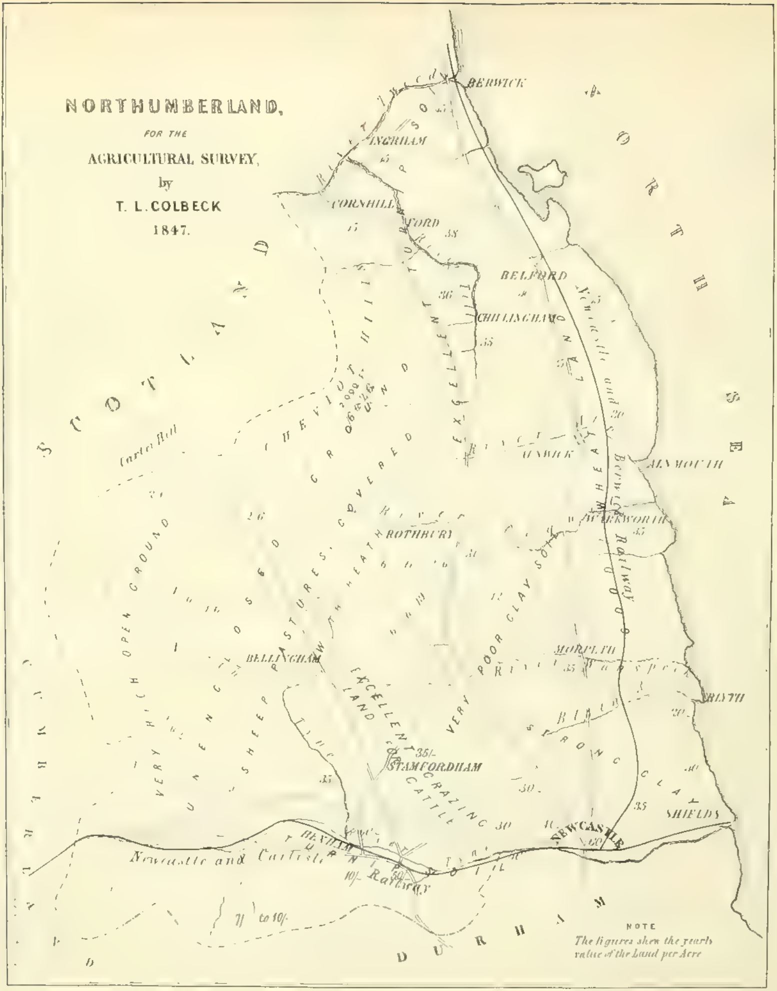
A few years ago the writer had an opportunity of comparing the condition of the farm-labourers of Northumberland with those of Somerset, Dorset, and Devon, and never can the difference be forgotten. At that time, the labourers here were receiving at least 50 *per cent. more* wages than in the southern counties, and, as already named, relief to able-bodied paupers is entirely unknown in Northumberland, the demoralizing, degrading effect of which practice upon the people is too well known to need any comment here. Although not so ambitious as our neighbours in Scotland to secure a classical education for the poor, there are very few of our farm-servants who do not manage to procure for their children the common rudiments of an English education. This combination of circumstances has produced in Northumberland a decidedly superior class of servants to those in many of the southern counties. In the populous districts, it is now customary for a great majority of the men to enrol themselves in "Self-supporting Sick and Burial Clubs;" and though they may not be on the best possible plan, they are a pleasing sign of a wish amongst the poor to place themselves above (what they consi-

der) the degradation of applying for parochial relief. It is still usual, in many places, to pay the yearly servants in the produce of the farm; however, as the men are beginning to find that they receive less actual wages in this case than when paid in money, the custom is fast dying away. The work on the farms is now principally done by resident married men, as their wives and children are found very useful, and more to be depended on than those of the neighbouring cottagers. The married men are always engaged for a year, and at present receive 14*s.* per week, with house and coals. The young men, who always reside in the farmer's house, receive about 20*l.* per annum, and the female servants about 9*l.* to 10*l.* There is every prospect of a rise in the price of labour, consequent on the demand caused by railways, and the general briskness of trade in the district. For the ordinary work on the farm, females are employed at 10*d.* per day, and nearly the whole of the harvest-work in the county is done by women, who are paid from 2*s.* to 3*s.* per day. Where they cannot be procured, Irish labourers are employed, generally at so much per acre and their food, the price varying with the crop.

With little fear of contradiction, it may be asserted that no portion of England has made such rapid improvement within the last forty years as Northumberland. At the time of Bailly and Cully's Report, it seems to have been usual to take two white crops in succession for one fallow (as is still done in the worst part of Ireland), and to continue to do so, until the land was worn out; after which, it was allowed to remain as many years in grass as it had been in tillage. The day in which such farming could be tolerated has, however, long gone by. In perusing the Report already named, it will also be observed that the point principally insisted on is to maintain a proper proportion between the grass and tillage land on each farm. However necessary such a plan might be at a time when the artificial manures were unknown, oil-cake as food for cattle unheard of, and the artificial grasses but little cultivated, no such necessity now exists. Indeed, as we have named, on the best turnip-soils old grass has long been dispensed with. Since the beginning of the present century, the farming of this county has undergone every species of trial between high prohibitory duties and free trade, notwithstanding which there has been a general steady rise in the value of land; and many estates, especially in the turnip district, now bring nearly the same rental they did when wheat was 150*s.* per quarter. It is mentioned in Bailly and Cully's Report that the weekly show of stock in Morpeth market was 80 cattle and 1600 sheep. This market was removed to Newcastle five or six years ago; and on the 28th November, 1846, there were shown 287 cattle and 4128 sheep! These figures certainly show a greatly increased produc-



CUMBERLAND
DURHAM
BELLINGHAM
STAMFORDHAM
HEXHAM
NEWCASTLE
SHIELDS
BLYTH
River Wanspeck
Blyth R.
Tyne
River Tyne
Newcastle and Carlisle Railway
VERY HIGH
UNENCLOSED SHEEP
EXCELLENT LAND FOR GRAZING CATTLE
VERY
STRONG CLAY
TURNIP SOIL
1/- to 2/-
5/-
7/- to 10/-
10/-
20/-
30/-
35/-
40/-
50/-
60/-
NOTE.
The figures shew the yearly value of the Land per Acre


NORTHUMBERLAND,
FOR THE
AGRICULTURAL SURVEY,
by
T. L. COLBECK
1847.
SCOTLAND
NORTH SEA
DURHAM
BERWICK
INGRHAM
CORNHILL
FORD
BELFORD
CHILLINGHAM
ALNMOUTH
WARKWORTH
ROTHBURY
MORPETH
BLYTH
BELLINGHAM
STAMFORDHAM
HEXHAM
NEWCASTLE
SHIELDS
CHEVIOT
Carter Fell
EXCELLENT LAND
VERY POOR CLAY SOIL
STRONG CLAY
VERY HIGH OPEN GROUND
Newcastle and Carlisle Railway
35/-
10/-
7/ to 10/-
NOTE
The figures shew the yearly value of the Land per Acre

tion; and there is no doubt but if the same means of comparison existed, there would be found an equal or greater increase in the production of grain. We have no hesitation in attributing this improvement mainly to the improved turnip husbandry, as the increase in cattle is in the face of many thousand acres of grass land having been brought under the plough: thus proving the striking fact, that we now can, with much less grass land than formerly, actually *feed more cattle, as well as grow more corn.* It must, however, be admitted, that whilst a part of the increased growth of corn is to be attributed to the grass land, brought into cultivation, and the application of artificial manures, some of it is owing to the draining, which has been extensively practised in the county for several years. As it is yet an undecided question how this improvement, draining, is best carried into effect, it appears advisable to state the different plans adopted, and leave it to experience to decide the question. On the Duke of Northumberland's estates, under the direction of Mr. Lorrain, the drains are cut 3 feet deep and 20 feet apart, the clay that is cut out being carefully spread over the land, and the tiles slightly covered with straw, or stones, if procurable. Soles, or tiles with bottoms, are always used. The entire cost is about *7l.* per acre, upon which the tenant is charged a per centage. On some other estates it has lately been the practice to cut the drains 5 feet deep and 30 feet apart, and the tiles are carefully *puddled* over with clay. Near Newcastle a third plan is followed: whenever springs or outbursts are seen to exist, they are first carefully cut off by deep stone-drains; afterwards furrow-drains are made, 2 feet to 2½ feet deep, and 20 feet apart; if of a greater depth than this, they are filled up *to the level of the plough* with some porous material, and the clay, taken out of the drains, spread over the land as far as possible from them. Whilst such very opposite plans are followed by persons of great experience, it is almost presumption in the writer to give his opinion, especially as the advocates of each plan are equally sanguine of success: there seems at present no other course but to look forward to the speedy settlement of the dispute, with anxiety commensurate with its importance.

It must, however, be acknowledged, that though much has been drained, sadly too much remains to be done. On some estates in the wheat district, which require it most, scarcely anything has been effected.

XIX.—*On the Cultivation of Flax.* By George Nicholls.

To extend the cultivation and improve the management of flax in its several stages of growth and preparation, are objects well worthy the attention of our English agriculturists, involving as these objects do highly important considerations, both in a social and an economical point of view; for an extension of flax culture, coupled with an improved system of management, will not only add to the national wealth by the production of a highly valuable commodity, but will at the same time conduce to the well-being of the working classes by enlarging the field of labour and the means of profitable employment.

The cultivation of flax is of very great antiquity. It is noticed as one of the crops grown in Egypt in the time of Moses,* and "fine linen" is spoken of in many parts of the sacred writings. Flax has been cultivated in India and Central Asia from the remotest periods, and is still grown there, chiefly, however, for the sake of the oil obtained from the seed. It was known to the Greeks and Romans, who used the fibre for making linen and other purposes, and it has continued to be grown for like objects throughout Europe to the present day.

The flax-plant is not restricted to any particular soil or situation, but flourishes over a great extent of the earth's surface, in the cold regions of Russia and America, as well as in the warmer climes of Asia and Africa. Hitherto it appears to have attained the greatest degree of perfection in Belgium and Holland, especially in the former country, where the utmost care is bestowed on its cultivation, as well as on the preparation of the fibre; and to this, rather than to any peculiar advantages in soil or climate, is to be attributed the general superiority of the Belgian flax.

Flax is indigenous to England, but when it was first cultivated here is not known: most likely in the time of the Romans, who were accustomed to its use, and knew the purposes to which the fibre was applicable. Its culture was probably continued after the Roman period; but we find no mention made of it in any public record until 1175, when flax was included in a list of *titheable* articles, and when its growth must therefore be presumed to have been considerable.

With wealth and civilization the use of linen would no doubt increase, as would the demand for flax, which of course would lead to its extended cultivation. Still, however, it appears not to have been cultivated to the extent required, for in 1532 the legislature passed an act (24 Henry VIII., cap. 14) requiring that

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* Exodus, 9th chap., 31st and 32nd verses.

every person occupying land apt for tillage, should for every 60 acres sow 1 rood at least with flax. This provision was re-enacted in 1541; and in 1562 (5 Eliz. cap. 5) the quantity was increased to 1 acre under a penalty of 5*l.* In 1691 (3 Wm. and Mary, cap. 3) with a view to encourage its cultivation, the tithe on flax was fixed at 4*s.* per acre, which was afterwards increased to 5*s.* by the 11 & 12 Wm. III. In 1713 a bounty of 1*d.* per ell was granted by the 12 Anne, cap. 16, on the exportation of British-made sail-cloth; and in 1806, 46 Geo. III., a bounty was offered for the importation of flax and hemp from our American colonies; and finally, in 1809, the sum of 20,000*l.* was appropriated to encourage the saving of flax-seed in Ireland.

These enactments show the importance heretofore attached to the growth of flax, and they likewise lead us to infer that our supply of home-grown flax was never equal to the demand; in consequence of which our manufacturers were then compelled, as they are compelled at the present day, to resort to foreign markets for an article which ought to be raised at home. Flax was nevertheless grown more or less in every part of England; and its use for domestic purposes was everywhere observable, the spinning-wheel being seen in almost every dwelling, from the cottage to the palace; and the thrifty housewife used to exhibit her stores of snow-white linen, the handywork of her own household, with as much pride as a modern fine lady now feels in exhibiting her worsted work and embroidery. The spinning-wheel is now rarely seen, and stores of linen are only found in the warehouse of the manufacturer, or in the shop of the retail dealer.

Hitherto one of the chief impediments to an extended growth of flax has been the notion generally entertained of its being a peculiarly exhausting crop. It was not unusual a century ago, and the practice is not altogether discontinued at the present day, to introduce covenants into leases restricting tenants from its cultivation, or limiting the extent and frequency of the crop. Despite of these restrictions, however, flax has continued to be cultivated, especially in the county of Somerset; and although for the most part it is roughly and imperfectly managed, so as to be fitted only for the coarser purposes, it has not, we may presume, been on the whole otherwise than remunerative to the grower.

The prevalent notion as to the very exhausting effects of the flax crop, was, nevertheless, it must be confessed, not altogether an exaggeration, for under the old system it returned nothing to the soil. The fault, however, lay in the management, not in the nature of the crop. All crops are more or less exhausting, in proportion to what they abstract from the soil, and to what they again return to it in the shape of manure; and measured by this test, flax under a right system of management will be found less

exhausting than grain crops, and probably as little so as any crop whatever.

It is well known that plants and vegetables of all kinds derive part of their nourishment from the earth, and part from the atmosphere. If the portion derived from the earth be again returned to it, no exhaustion takes place, and successive crops may be raised without injury to the productive energies of the soil. Now no crop will return more of what was derived from the soil than flax, provided a right application be made of the seed and refuse of the plant. It has been shown in a series of carefully conducted experiments by Professor Sir R. Kane, that the fibre of the flax-plant is obtained entirely from the atmosphere, that no part of it is derived from the soil;* and therefore, if the other portions are returned to the soil, as they may and ought to be, its powers will remain undiminished, whilst the fibre, the most valuable portion of the plant, would be left for the benefit of the cultivator.

One great object to be aimed at therefore in flax culture, and which is in fact hardly second in importance to that of producing the best description of fibre, is such a disposal of all the other portions of the plant as shall ensure their return to the soil in the shape of manure. This object has hitherto been little attended to, and hence the prevalent notion as to the peculiarly exhausting nature of the flax crop; but now that the value of the seed for fattening cattle has been so fully proved by Mr. Warnes of Norfolk and others, every farmer will be enabled, by applying the seed of his flax crop to that purpose, to obtain a supply of the richest manure, which, with the offal separated from the fibre in course of preparation, will serve to renovate the soil and secure its undiminished fertility.

The chief difference therefore between the mode of cultivation hitherto practised, and that now recommended, consists in this:—by the old plan the seed and refuse were wasted or sold off the land, and nothing was returned to the soil: but by the new plan the seed and refuse are carefully preserved, and the former is applied to the fattening of cattle; and thus every portion of the plant except the fibre (which as before shown is obtained from the atmosphere) will be returned to the soil. This would doubtless be the proper practice under any circumstances, but it is peculiarly applicable to England, where animal food is so largely consumed. In no other country can flax-seed be applied to feeding purposes with greater advantage; and if restriction of any kind be resorted to, it should be not to prohibit the growth of flax, but to prevent the tenant from selling the seed off the farm, and to re-

* See extracts from a Memoir by Professor Kane, as given in the appendix of the third Report of the Irish Society for promoting the growth and improvement of Flax.

quire him to use it for fattening cattle and increasing his stock of manure.

Another circumstance which operated to discourage the cultivation of flax in this country, was the introduction of cotton, and the application of steam-power and machinery to spinning and weaving the cotton fibre, which so greatly reduced the cost of fabrics made of that material, that they in a short time almost entirely superseded linen in the ordinary clothing of the people, and flax became less in demand.

But within the last twenty years, the ingenuity of our mechanics has succeeded in applying steam-power and machinery to the preparation and spinning of flax; and the great difference which before existed between the prices of cotton and linen fabrics has in consequence been so much reduced, that at present the latter may be considered as cheap as the former, having regard to the durability of each. This has led to a more extended use of linen; and as the home growth has not increased, or at least not at all in proportion, the quantity of foreign flax imported has of late years been very considerable, as appears by the following statement abstracted from the Parliamentary Returns:—

		Tons.	Cwt.
1842,	Flax imported . .	57,287	19
1843,	,, . .	71,857	10
1844,	,, . .	79,174	14
1845,	,, . .	70,921	3
	Average of four years .	69,810	6½

If we assume 50*l.* per ton to be the average value of the flax imported in the above four years, it will have cost the country 3,490,520*l.*, or close upon three millions and a half per annum, to obtain an article which might have been produced at home with profit to the farmer, with benefit to the labouring population by the increased employment it would have afforded, and with advantage to the whole community.*

* Mr. Nicholls is a very able advocate, and in this excellent report he brings fully before us all the advantages likely to result from the extended cultivation of flax. It could scarcely be expected that he should also argue the opposite side of the question; but, whether treated as a question of grave national import, or merely as one of individual profit and loss to those about to commence flax growing, it appears to me very important that, together with the above startling items of national expenditure, we should also have before us a brief sketch of the set-offs which must be entered in the national ledger, before a balance can be struck for or against this particular crop.

It would doubtless, at first sight, be considered hyperbolic to state, that by growing in the United Kingdom the amount of flax now imported (va-

Seeing then that flax is not of necessity an exhausting crop, but on the contrary, under proper management, a highly restorative crop; and seeing that the application of machinery to the spinning of flax has so reduced the price of linen as to bring it into successful competition with fabrics formed of cotton, thus

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lued above at three millions and a half per annum), we should displace corn now grown in the British Islands to at least three-fourths of that amount; yet that such is the fact, a few sentences will suffice to show. To avoid even the appearance of impugning in the smallest degree Mr. Nicholls' statements, I will take his figures as the basis of my calculation, and assume in round numbers that 70,000 tons of flax are annually imported, and that (as is subsequently stated) forty stone of flax (value 7*s.* 6*d.* per stone) is the average produce of a reasonably well cultivated acre of flax. At this rate the 70,000 tons of imported flax would require 280,000 acres of land for its production. In what state must this land be to produce forty stone of flax per acre? Mr. Nicholls very justly considers it indispensable that the land should be "clean and in good tilth," i. e., precisely in the state in which it is best fitted for producing corn. Now, if in England, as in America or Australia, there existed an almost unlimited extent of fertile but uncultivated land, then, indeed, it might be taken for granted that any article of import which could be grown at home, would be a saving to the nation of the whole sum formerly paid on that account, because the previous products of the soil need not be diminished to make room for it; but in England every acre, of even moderate fertility, has its work to do, and no new crop can be introduced without displacing an old one. The only way therefore of calculating the probable advantage of extending the cultivation of the flax crop, is by striking a balance between the net produce of an acre of flax, and that of the same acre if otherwise cropped. From personal observation in Belgium, I can state that it is there an invariable rule to put the land into higher condition for flax than for any other crop they cultivate, and if the land is not in this high condition before sowing, they apply very large quantities of liquid manure to the growing plant. If further confirmation of this were needed, I would refer to Mr. Rham's Report on the Agriculture of the Netherlands (see *Journal*, vol. iii. p. 245), where the manure for an acre of flax is stated at 12 tons of dung, 50 barrels of urine, and 5 cwt. of rape cake. I do not suppose that any such manuring as this would be requisite or even advisable in this country; but *I have no doubt* that an acre of land which is able to produce forty stone of flax (value 7*s.* 6*d.* per stone) would, in an average season, produce at least four quarters of wheat. The 280,000 acres required to produce the flax now imported, would therefore produce, if cropped with wheat, 1,120,000 quarters worth (at 7*s.* per bushel) 3,136,000*l.*, which approaches tolerably near to the estimate given by Mr. Nicholls of the value of the imported flax, viz., 3,490,000*l.* The value of the flax-seed has not been taken into account, conceiving that what was not required to sow again would be consumed on the farm: should it, however, be valued for sale, credit must on the other hand be taken for the wheat straw, which is also supposed to be converted into manure. It is clear from the preceding rough calculation, that though the cost of the flax imported annually into the United Kingdom is very great, yet that the balance in favour of substituting it for other crops is not so large as to make it a matter of great importance, independently of the question of employment for the labourer, which is too extensive a question to be discussed in a note. H. S. Thompson.

making England less dependent upon the cotton-producing countries in case of failure of the crop, or interruption of the supply from political or other causes; and seeing moreover that the home growth is very much below the demand, and that its extension would be fairly if not highly remunerative—having regard to all these circumstances, it hardly seems necessary to state other reasons in favour of extending flax culture in this country. But there are nevertheless a few other considerations which ought not perhaps to be altogether passed over, and to these I will now briefly advert.

The quantity of flax imported in the last four years has just been stated—I will now state the quantity of linseed and oilcake imported within the same period, in order that the entire value of flax produce imported may be seen at one view.

	Linseed. Qrs.	Oilcake. Tons.
In 1842 there were imported	367,700	67,293½
1843 " "	470,539	63,267¼
1844 " "	616,947	85,890
1845 " "	633,293	74,681¼
Average of the four years	522,120	72,783

Taking the average of the four years, and assuming the average price of the seed to be 2*l.* 5*s.* per quarter, and the average price of the oilcake to be 8*l.* 10*s.* per ton, it will give 1,174,770*l.* as the value of one, and 618,655*l.* as the value of the other, and show an outlay for both of 1,793,425*l.*, which, added to the cost of the flax as before stated, gives a total outlay, on an average of the four years, of 5,283,945*l.*, or five millions and a quarter sterling per annum.

If, however, the cultivation of flax were to be so extended as to supply home-grown fibre sufficient to meet the entire demand, an importation of foreign seed and oilcake might still be required, the latter for feeding purposes, and the former for extracting the oil, linseed oil being an article in very extensive use. A demand for foreign linseed and oilcake might thus continue, although it would to some extent be lessened by the quantity of home-grown seed produced; but if this latter, as well as the imported oilcake and that procured from the oil-pressers, were applied to fattening cattle, an additional supply of valuable manure would thereby be obtained, which would give increased fertility to the land for other crops.

The quantity of flax which ought to be cultivated in any locality, must in some measure be governed by the quantity of labour there obtainable; for as the management of the crop in all its stages requires a considerable amount of labour, the farmer must propor-

tion the quantity raised, to the means at hand for its management. One acre in a hundred, and one in fifty, have each been named as a suitable proportion to be applied to the growth of flax. It has been seen that in former times the farmer was by law required to cultivate one acre with flax, out of every sixty acres occupied. All such rules are, however, obviously incapable of strict application. The quantity must in every case be governed by local circumstances, and be left to the farmer's own discretion; always bearing in mind, that the more flax the more employment for the people, the more fattening material for his cattle, and the more manure for his land.

If the quantity of flax grown be limited by the labour which can be obtained, so may the amount of obtainable labour be said to indicate the extent to which flax culture ought to be carried in any locality. To keep the rural population fully and profitably employed, is unquestionably the interest both of the farmer and the landowner, they being each liable to support the people, whether employed or not; and there is no description of crop which affords so much employment as flax, or that yields the same return for the labour employed upon it.

It is calculated that an acre of good flax as it stands in the field, containing, say about 50 stone of fibre, will afford employment for from twelve to fourteen weeks to a man skilled in the several processes of its preparation. A woman, or young person less skilled and less able, would require twice that time, at least, before the flax could be made ready for the manufacturer. It must not be inferred from this calculation, that the work is to be performed by men singly, or by women or young persons singly. The preparation of the flax in its several stages affords employment for each, but in a much larger degree for the two latter classes, the labour being for the most part light, and well suited for women, and boys and girls. All such estimations, however, must be taken as approximations merely, without pretension to minute accuracy: but the above will serve to show the great amount of employment afforded by the flax crop in its various stages, and more especially to the class of persons for whom employment is most difficult to be found, a large portion of the labour being usually performed by females.

In this point of view, the extension of flax culture becomes an object of important consideration with reference to the social condition of the agricultural labourer, for if eligible employment can thus be found for his wife, and also for his children as they attain a suitable age, it will be a great relief to him, and of infinite service to them. The females will then no longer be necessitated to resort to fieldwork in common with men, and the union or the parish will not be habitually applied to in every

interval of employment. Indeed, such intervals will then be less frequent, for flax may be worked *at any time,* winter or summer, and in any weather, and will thus supply a great desideratum by rendering employment continuous.

Such has been the result at Trimingham, in Norfolk, where the labourers used to be frequently out of work; but since the cultivation of flax has been introduced into that parish, every one finds employment, and the poor-rates have been reduced nearly one-half within the last three or four years—not, however, it must be observed, through the direct employment afforded by the preparation of flax alone, but likewise by the use of the seed in fattening cattle and in making manure, by which the quantity of other crops has been greatly increased, and the amount of employment proportionably extended. On all these accounts, therefore, the cultivation of flax cannot be too strongly urged upon our agriculturists of every class.

In Belgium flax is called "the Golden Crop," and in Ireland it is called "the Rent-paying Crop." There is much truth in both these designations, which I have no doubt would be equally applicable to this country, if the same attention were here paid to its cultivation.

It has been disputed whether flax is most to be valued for its seed or for the fibre. The zealous agriculturist stickles for the seed, as affording the means of fattening his cattle, and providing manure for his land. The manufacturer, on the contrary, contends for the fibre, and cites the high price which flax of superior quality commands in the market. Both parties are perhaps correct in their estimate of the great value of each portion of the produce, and flax might possibly be cultivated for either the one or the other singly with advantage; but there is no necessity for such a separation—the seed and the fibre may both be obtained without injury to the quality of either, and flax will thus become a double crop, equal, if not superior, in value to any other which can be raised from the land.

Various estimates have been formed of the profits to be obtained by flax culture, ranging from six and eight, to ten, fifteen, and twenty pounds per acre, and even still higher. Of this more will be said hereafter, and it is only necessary here to observe, that the flax crop, under average circumstances, affords such a reasonable expectation of adequate return, as will warrant any prudent farmer occupying suitable land, to enter upon its cultivation, Before doing so, however, he ought to obtain all requisite information for enabling him properly to conduct the management in its several stages, and this information it will be my endeavour in the following pages to afford.

Having stated thus generally the importance of extending flax culture in this country, and pointed out its advantages to the farmer, and the benefits it would confer upon the agricultural labourer, I now proceed to describe the mode of cultivation best calculated for ensuring the perfect growth of the plant, and the mode of preparing the fibre in its several stages until it becomes fitted for the market; after which, I shall advert to the importance of preserving and rightly using the seed.

I must premise, however, that in these several processes there is nothing more difficult to learn or to practise, than in the ordinary operations of husbandry. In hand-scutching, for instance, a person would find about as much difficulty at first, as on first attempting to plough, or to use the scythe, the flail, or the sickle. Each will be found more or less difficult, until familiarised by practice. But there is this difference in the two cases—in most operations of husbandry, considerable strength and muscular energy are required, whilst in the preparation of flax, sharpness, tact, and agility are the chief requisites; and hence it is a species of labour peculiarly fitted for women and young persons of both sexes. A lad not more than 12 years old, was pointed out to me at Trimingham as one of the best scutchers in the parish, and he certainly handled the swingle, or scutching tool, with perfect facility, and seemed to take great pleasure in the occupation.

It will, I think, be convenient to take the several operations in the following order:—

1st. The cultivation, which includes the preparation of the land, sowing the seed, and weeding, and pulling the flax.

2ndly. The preparation of the fibre, which includes the several processes of stooking, stacking, rippling, beetling, steeping, spreading, lifting, breaking, and swingling or scutching.

3rdly. The preservation and use of the seed.

1st. *Cultivation of the Flax.*

The growth of flax is not limited to any particular soil or situation. It flourishes in the light soil of Flanders, in the deep alluvial deposits of Holland, in the limestone and the peaty soils of Ireland, and on almost, if not on every variety of land in England. It has been grown on the Wicklow mountains a thousand feet above the level of the sea, and has flourished even at that elevation on cold granitic moory soil, which in its natural state produced nothing but heath. Like our grain and other crops, flax may show a preference for certain soils and situations, but it will flourish and attain maturity in all, if proper care is bestowed on its cultivation.

The land must be clean and in good tilth. This is necessary

for every description of crop, but it is especially necessary for flax; as, unless the ground is well worked and brought to an even surface, the seed cannot be evenly sown, and even-sowing is essential to the even growth and perfection of the plant.

The advantages derived from draining and subsoiling are now so well understood, and so generally admitted, that it is needless to say more with respect to these operations, than that they are as necessary for flax as for any other crop. But although the land should be well drained, flax will bear a good deal of moisture, and in fact thrives best in a moist climate. Hence the peculiar suitableness of England for its growth, our climate being generally more humid than that of the continent, especially in the western counties. Indeed, long continued drought is the chief enemy the flax grower has to dread. He is rarely injured by excess of moisture, provided his land be thoroughly drained.

Flax generally thrives best after wheat, and on new soils, and it may often be advantageously grown on rough unbroken land if it be properly worked. In Ireland flax is seldom grown after potatoes, for which the ground being in general highly manured, causes the flax to grow rank and coarse. The same objection would apply in this country; but in either case, if new land be broken up for the potato crop, flax may often succeed with advantage. It is not, however, found to thrive after turnips, at least there are instances recorded of its failure when sown immediately following a turnip crop, which ought therefore to be avoided.

Flax does well after wheat, and wheat does well after flax. The two crops appear to have a peculiar relation, neither abstracting from the soil the kind of nourishment required by the other. It would be worth while to ascertain how long alternate crops of wheat and flax could be grown without deterioration to either. Such an experiment might be useful as a guide in regulating the general rotations. Flax does well, likewise, after peas and beans; and as these crops are especially useful when combined with the flax-seed in cattle-feeding, they should be included in every rotation of which flax forms a part.

The extent to which flax can be advantageously grown in any particular case, must depend in great measure upon the size of the farm, and the nature of the rotations to which it is subjected. On small farms it may be included in the general rotation with some degree of regularity; but on extensive farms, where the enclosures are large and the breadth of crops considerable, this can hardly be done; and flax may there most conveniently come in for a portion of the land in turn for turnips.

In Belgium it is the usual practice to grow flax after corn, and seldom oftener than once in five years. Some persons recommend intervals of seven years, and others of ten years; but if the

land be properly managed, I know of nothing in the flax crop requiring different treatment in this respect from any other description of crop, whether green or yellow.

Various rotations are recommended as having been successfully practised in different localities, and a few are inserted by way of appendix at the end of this article,* in order that the judicious farmer may select the one which appears to him best, or devise from the whole something most suitable to the nature of his land and his own particular position.

In Flanders a great variety of crops is raised, the farms being for the most part small, the majority varying from 8 or 10, to 20 and 30 acres. House or stall feeding the cattle is there, likewise, universally practised, which gives a large supply of manure, and enables the farmer to keep the whole of his land under crop, and thus to have a greater variety of rotations, flax, however, being never omitted; for every Belgian farmer, whether large or small, grows flax sufficient to keep himself and his people employed when not at work on the land.

Sowing.—We will assume that the land is in all respects properly prepared—that it has been thoroughly drained, is in good heart and good tilth, and has been ploughed three times at least in autumn and spring; that the harrow and the roller have been in active operation, the clods broken and completely pulverized, the root weeds carefully picked off, and the ground brought to a smooth and level surface. These are all essential to good husbandry, and must on no account be omitted in the cultivation of flax, which will not thrive under slovenly management. If the surface be rough, uneven, and imperfectly wrought, the seed cannot be equally distributed, and the plants will grow patchy and irregular, to the injury of the crop both in quality and quantity.

Proper care having thus been taken to prepare the land for receiving the seed, the next consideration is the time of sowing; and on this point the great importance of sowing early cannot be too strongly urged. In nine cases out of ten, early-sown flax will be better than that which is sown late. As soon as the ground can be got ready, put in the seed. This may generally be done in March, and if in the first week so much the better. The earlier you sow, the better will be your crop, and the sooner will it be ready for pulling, which is an important consideration; for it will interfere less with the general harvest to pull the flax early in July than if it runs into August, as it will do if sown late. Moreover, if the flax is off the land early, a crop of turnips or rape may often be obtained after it; or, if this should not be desired, the ground will have the benefit of half a summer's fallow.

* See Appendix A, p. 469.

When the seed is sown, it should be covered by two strokes of the light seed-harrow, once up and down, and once across, then finish with a light roller, leaving the seed equally covered about an inch in depth. Broadcast is the best mode of sowing flax-seed. Some persons advocate the use of a drill, set very close, as is sometimes used for grass-seeds; but on the whole, it seems now generally admitted that broadcast is to be preferred for flax.

The quantity of seed to the acre depends much on the kind of flax required. For fine flax, sow thick. If flax of a stronger and coarser description is wanted, or if the seed is a principal object, sow thin. When thickly sown, the flax grows tall and straight, yielding little seed; but the fibre will be of superior length and fineness. When sown thin, the flax grows more coarse and branchy, producing much seed, but affording an inferior quality of fibre.

As a general rule, 3 bushels of seed per acre should be sown for fine flax; 2 bushels per acre for flax of a medium quality, yielding both seed and fibre; and six pecks where seed is the primary object. If particularly fine flax is desired, such as the Flemings raise for their finest lace and cambrics, very thick sowing must be resorted to, as much as 3½ or 4 bushels to the acre; but the demand for this description of flax is comparatively small. The medium quality is most in demand for the purposes of the manufacturer, and a large quantity of the stronger and coarser kind is required for every day use by our traders and handicrafts of every description.

The Seed may be either home-grown or foreign, flax equally good being raised from both. It should be clean, plump, and heavy. If light, thin, or dull in colour, it is of inferior quality, and should be rejected. Much loss and disappointment occurred in Ireland three years ago by using foreign seed of this description, which turned out to have been kiln-dried, and its vegetative principle thereby destroyed. A change of seed every second or third year is advantageous for flax as for other crops, and an occasional use of Dutch Belgian or Riga seed may be resorted to as affording the completest change, care being taken to sift and thoroughly cleanse it from the seeds of weeds with which all foreign flax-seed is more or less mixed. American seed is said not to answer so well as Riga and Dutch, the flax growing coarse and branchy.*

* The cultivation of flax appears to be extending in America, especially in the Canadas. The following is an extract of a letter dated June, 1846, from Newmarket, Upper Canada:—"In the spring of 1844 I sowed 2½ acres, which yielded me 500 lbs. of clean scutched flax per acre, and 22 bushels of excellent seed per acre. I was so well satisfied with this, that

I must not omit to state, however, that of all the flax-seed produced at market of late years, that grown in England appears to be the best, both for its great weight and freedom from weeds. It is true the quantity raised is at present small, but this will not always be the case, and we may reasonably expect at no distant day that Ireland will obtain from us the seed required for sowing, affording in return the seed required here for like purpose. The two countries will then be enabled to supply each other's wants in the best manner, without resorting to foreign aid.

It has been recommended, as a means of obtaining a change of seed, to sow a patch of land with foreign seed, Riga being considered the best for the purpose. The seed is to be sown thin, and the crop allowed to stand till thoroughly ripe, the fibre being in this case a matter of no importance. The seed obtained from this crop will be ready for the next year's sowing; and the farmer may thus not only secure clean and perfect seed, but he will likewise obtain a change in the most convenient way. This plan may be followed as often as fresh seed is required.

Weeding.—If the land has been properly cleaned and prepared, and if all the root weeds have been carefully picked off before sowing, there will be little need of weeding afterwards. If any of the stronger weeds appear, they must be removed, and this may readily be done by women and children, who should be cautioned to tread and trample the flax as little as possible. The smaller description of weeds will soon be overtopped by the flax, which grows rapidly, and is therefore a smothering crop, and helps to clean the ground.

Pulling.—Various rules have been given for ascertaining the proper time to pull the flax. If pulled too soon, the fibre may be fine; but there will be great waste in scutching, and the seed will be of little value. The best rule is to pull as soon as the seeds begin to get firm, and change to a pale yellowish or greenish brown colour, and when the stem has become yellow for about half or two-thirds its height from the ground. A little practice will, however, be the surest guide on this point; and on the whole there is, perhaps, less danger from pulling too early than from pulling too late.

I sowed, in the spring of 1845, 13 acres of flax, and 3 acres of hemp. This also turned out well; and I have now in the present season 45 acres of flax and 8 acres of hemp. I find it difficult to obtain first-rate flax-dressers. I could afford to give a good flax-dresser piece-work, so that he could earn 18*s.* per week, and in long days as much as 1*l.* per week, Halifax currency; and I could give two or three families constant work in the flax business."

Upon uneven or imperfectly cultivated land, the plants will grow unevenly, and of various lengths; and under the best cultivation some will grow to a greater height than others. This must be attended to in pulling, it being important to keep the different lengths separate. The Dutch and Flemings accomplish this by first pulling a handful of the longest, seizing it just below the bolls, and then pulling the shorter. Each kind is laid separate on the ground in rows, and kept perfectly even at the ends, the bolls of one handful being placed by the root ends of the other; and each kind is separately stooked. This mode of pulling and separating the stalks according to their lengths causes a little additional labour at the time, but it will be fully recompensed by the greater ease with which the after processes are performed, and by the increased value of the fibre. Should there be any weeds mingled with the stalks, they must be removed at the time of pulling, as they would be apt to stain and injure the colour of the flax.

It is not unusual with the Belgian farmers to sell their standing crop of flax to a factor, who takes upon himself all the subsequent expense and risk. The factor pulls and removes the flax to some favourite locality for steeping, where the several operations are performed on a large scale by expert workmen, which enables him to obtain a more valuable description of fibre than the farmers would, probably, be always able to produce. This factoring system has been recently introduced into Ireland, and is recommended by the Irish Flax Society as a means for effecting improvement in the general management of the flax crops in that country. The factors employ persons who understand the business to conduct the several processes with due care and punctuality, thus setting an example to the small Irish farmers, who are unfortunately often prone to be negligent and remiss, where precision and exactitude are required.

It is likewise a frequent practice in Belgium, for the farmer to pull, dry, and stack his flax, and afterwards sell it to the factor, who removes it to a steeping station, and there conducts all the subsequent operations in the same way as if it had been purchased green. When thus dried and stacked, the flax may be kept for any length of time, and be steeped and prepared for market whenever it best suits the farmer's or the factor's interest or convenience.

The practice of factoring, as above described, might no doubt be introduced with advantage in this country, especially in the vicinity of good steeping-places, which would most probably be found in lakes or large ponds, or pieces of ornamental water supplied by a brook or stream. The flax might there be sunk in crates or frames, similar to those used in the neighbourhood of Courtrai;

and if similarly treated, there can be no reason why our English flax should not be in all respects as good as is there produced.

If steeping establishments under the charge of persons skilled in that particular department, were formed in eligible situations, the neighbouring farmers would bring their flax for steeping on their own account, whenever they deemed this more advantageous than selling it to a factor, as in some, if not in most cases, it probably would be. With reference to these stations, I must not omit to state that it has been proved by experience, that fish are not affected by the steeping of flax when it is freed from seed—a fact of some importance to the owners of lakes and ornamental waters, who may allow flax to be steeped therein, without danger of injury to the fish.

The value of an acre of standing flax has been variously estimated. In Belgium it is said to be from 19*l.* to 25*l.* In Somersetshire, where most of our English flax has of late years been grown, it is estimated at 21*l.*; and in Ireland as high as 27*l.* These estimates appear high, and are probably somewhat in excess; but it may on the whole, I think, be reasonably assumed, that an acre of flax, if well grown and of fair medium quality, is worth between 15*l.* and 20*l.* to the grower, including the seed. What deduction should be made in dealing with a factor, in case the farmer decides upon selling his crop standing, the factor taking all the risk and expense of preparing it for market, must of course depend very much upon local circumstances, and be a matter of arrangement between the parties at the time.*

2. *Preparation of the Fibre.*

Assuming that the flax has been pulled as directed under the last head, each handful being laid separate in rows on the ground, the bolls of one handful by the roots of the other, and all kept perfectly even at the root ends—the next thing to be done is

Stooking.—In doing this, the long and the short flax must be kept apart, in separate stooks. Women and children are employed to carry the handfuls to the stooker, who sets them up in rows, with the bolls resting against each other, and the root ends extending outwards in the form of the letter A. The stooks may be made of any length most convenient, each end being strapped together by a few stalks of the flax, to prevent their being blown down; and here the crop may remain secure from the wind and weather, to dry and ripen in the field as long as is necessary. After it has

* It is true that 30*l.*, 40*l.*, and even 50*l.* per acre are sometimes realised in the best flax-growing districts, but such instances are comparatively rare, and the return above estimated must be considered sufficiently remunerative on an average of years.

been in stook a few days the stooks must be turned, in order that all parts may be equally dried, which is rapidly done by a person accustomed to the work.

When the flax has become sufficiently dry to prevent its heating, which it generally will be in a week or ten days, according as the weather is favourable or otherwise, it must be tied up in small sheaves or beets, and may then be carted home, and be either housed or put into stack, at the farmer's option. When the crop has thus been secured, the farmer can choose his own time for beetling and steeping, and also for the subsequent operations of scutching and preparing the flax for market. This is a great advantage attendant on flax culture, affording the means of employment at periods when other farm employments have ceased, and when the labourers' families, if not the labourers themselves, would else be out of work.

Beetling.—Before the flax thus secured is steeped, it is necessary to separate the seed by beetling; and this is usually done by a beetle or block of wood, about 9 inches long and 4 inches square, into which a handle of convenient length is fixed, and with which the seed is readily beaten out.

Where flax is steeped green, the seed is separated by rippling as soon as the flax is pulled—that is, by drawing the stalks through a row of iron spikes set upright in a wooden frame, and so close to each other as to catch and separate the bolls as the stalks are drawn through. In this latter case of rippling, the bolls which contain the seed must be dried before the seed can be separated, and it must then be carefully sifted and cleansed before it is laid by. In the former case of beetling, the seed is already dry, and has merely to be winnowed, like grain, to free it from the chaff.

Steeping.—This is sometimes called watering, and is usually performed in spring, but it may be continued throughout the summer and autumn. Steeping is the process by which the vegetable matter connecting the stem and fibre is decomposed by immersion in water, and after which these portions of the plant are readily separated. The value of the flax depends very much upon the manner in which this process is performed, and the Belgians and Dutch pay great attention to this part of the management. In Flanders the water of the River Lys is considered particularly good for steeping, and vast quantities of flax are sent thither from great distances for the purpose. Steeping is there carried on as a regular trade, by men constantly employed in it. The flax is put into frames or crates prepared and kept for the occasion. These are floated into deep water, and sunk by weights below the surface, but not so as to touch the bottom; and the

whole operation is conducted in an orderly and business-like manner.

The softest water is unquestionably the best for steeping, and hence river water is preferable to spring. A slow-running stream is likewise better than stagnant water, inasmuch as it carries off impurities, and gives the flax a better colour, which is an important consideration, as respects its market value.

But it is not always that access to rivers, nor even to lakes or large ponds, which are held next in estimation, can be obtained for steeping; and where this is the case, recourse must be had to other means. Steeping-pools must then be constructed, and these may be most conveniently formed by the side of rivulets or small streams; or if there are none such sufficiently near, the water may be conducted into the pools from distant brooks or springs. With every care, however, steeping-pools may not always give the best colour to the flax, and whenever practicable, it should therefore be sent to the most approved steep, even although it may be distant and expensive; for it will well repay the cost, by the enhanced price the flax will command in the market.

The steeping-pool may be made from 4 to 6 yards long, and 2 yards wide, a little more or less according to circumstances, and 4 feet deep. It should be well puddled, and be protected from the influx of surface water. If a small stream can be carried through the pool, so much the better; but if filled from a spring, the water should be let in some time before it is used, in order that the sun and air may soften it, and it should be perfectly clean, and free from mineral and vegetable taint of any kind.

When crates or frames are not used, as they rarely will be except in rivers or large waters, the bundles or beets of flax must be placed in steep with their root-ends downwards, and be laid close, a little slanting, and in regular rows. They must then be covered lightly with straw or rushes, over which hurdles should be placed, weighted with flat stones, logs of wood, small tubs filled with water or any weighty substance. The flax must be kept 4 or 6 inches under the surface of the water, but it must not touch the bottom, and weights must be added or lessened to keep it suspended in this position.

In from 7 to 10 or 14 days, or sometimes even longer, according to the nature of the water and heat of the weather, the flax will be sufficiently steeped; and it is important to know when this is the case, for it would be injured if kept too long in the water. The Dutch test in this respect is to try a few stalks by breaking them at two places, about 3 inches apart, near the middle of the stem; and if the 3 inches of the wood so broken separates easily on being drawn downwards, without tearing the fibre, the flax is sufficiently

steeped. This test may be relied on, and the trial should be made twice a-day after the fermentation subsides, for the change is then often very rapid.

If, notwithstanding every care, it should be found that the flax has been taken out of steep a little too soon, the error may in great measure be rectified by allowing it afterwards to remain a little longer on the grass; but if permitted to remain too long in steep, the evil is irremediable.

The steeping-pool, if properly constructed and properly attended to, will answer nearly as well as the larger waters for flax of average quality, although the best colour may not thereby be obtained. It will, however, if rightly managed, be far preferable to steeping in ditches, mingled with every kind of filth and impurity, as has been the common practice in this country, thereby injuring the texture of the flax, and making it of a dark and dingy hue, instead of the soft yellow or light straw colour which is so much prized by the manufacturer.

Spreading or Grassing.—When sufficiently steeped, the flax must be removed carefully from the water, without being broken or crumpled by rough handling, and either set up on the root-ends to drain for a short time, or it may be immediately spread; but it will soon heat if allowed to remain in a heap. If the weather is rainy, it need not prevent the spreading, for which a clean short pasture should be selected; and the flax must be laid evenly, in regular rows, and so thin that the grass may be seen through the stalks.

When it is not intended to grass the flax immediately that it is taken out of steep, as is sometimes the case, the bundles are first left an hour or two to drain, and are then untied and formed into what are called caps, of a conical form, having the appearance of very small tents. This is done with great rapidity after a little practice; and when they have stood some time, these caps are turned inside out with like rapidity, in order that the whole of the flax may be exposed to the sun and wind, and be thoroughly dried. It may then be tied up in beets, and carried home, and stacked or housed until it is wished to grass and prepare it for market.

From 3 to 6 days, or longer, according to the state of the weather and nature of the fibre, will be required for the flax to remain on the grass, and whilst spread it must be repeatedly turned, in order that every part may be equally bleached. The turning is effected very rapidly, without disturbing the order of the rows, by means of a rod about 8 feet long slipped under the flax as it lies on the grass. Wherever the flax is spread, the grass will be found to grow with great vigour. This is particularly the case in the spring, and may be taken advantage of by the farmer

to obtain early feed for his stock, the grass always shooting up luxuriantly under the flax.

Lifting.—If on rubbing the stalks a few times from top to bottom in the hand the wood separates easily from the fibre, the flax has been long enough on the grass; but if there is any doubt on the point, try it on the hand-break. When thus proved to be ready, proceed to lift it, if perfectly dry, keeping the lengths straight and the ends even, and tie it up into small beets or bundles.

If not perfectly dry, it will be advisable to lift the flax and set it up in caps for a few hours, before it is tied in bundles; and in damp and fickle weather the beets should be put up in small stacks, loosely built, so that the air may pass freely through them, and thus prevent their heating. It is important that flax of the same quality and colour should be kept together, and this ought to be attended to in lifting. Select the best of every row in the first instance, and place the bundles separate; then gather up the next best in like manner, and so on till the whole is arranged in distinct lots, according to quality. A mixture of qualities always lessens the value, and this should be guarded against in lifting.

The colour of the flax will mainly depend upon the way in which the steeping and grassing have been conducted, and its value in the market will depend very much upon its colour, which should be of a clear soft yellow, approaching to white; but if it is at all dull or dark in colour, as will be the case when steeped improperly or in bad water, or if not well attended to whilst on the grass, it will command a less price from the manufacturer.

Breaking—is the act of bruising the stem of the flax, and breaking it into short lengths, so as to admit of its being easily separated from the fibre in the process of scutching. Breaking is performed either by the hand-break, or by machines, of which there are several kinds. The hand-break is a very simple instrument, well calculated for use in a small way. It consists of two pretty substantial frames, made of wood, and fixed on four legs; each frame is about 3 feet long and a foot wide, and has four or five bars or battens fixed lengthwise within it. The frames are connected by a hinge at one end, and the upper one has a handle fixed at top, by which it is worked up and down, whilst the operator with his other hand draws a small quantity of the stalks slowly between. The battens are so fixed in each frame as to form grooves of corresponding widths, fitting loosely into each other; and the upper frame being forced down by successive rapid strokes upon the lower, bruises and breaks the stem of the flax, and thus prepares it for the scutcher.

If the quantity of flax be considerable, instead of the hand-break, recourse may be had to the breaking-machine, which consists of four or six pairs of deeply fluted rollers, fixed horizontally in a frame, and worked similarly to a thrashing-machine. The rollers may be formed either of wood or iron, but the latter is decidedly preferable. By this instrument, breaking is very rapidly performed; and wherever there are horse-works, or steam or water power on a farm, the break (being portable) may be attached to the gearing, and the whole process will be speedily and cheaply accomplished. A few women, or a few boys and girls, will be required to hand the bundles to the man attending the break, and to receive them after they are passed through. The flax must be placed straight and regular in the break, and order and promptitude should be observed throughout the whole process.

Scutching or *Swingling*—is the act of clearing the fibre from the woody part of the stalk after it has been bruised and loosened by the break. This is the last step in the process of preparation, and the value of the flax will depend, in no inconsiderable degree, upon the manner in which it is performed. If the flax has been well grown, the fibre will be long and even; if it has been well watered and well grassed, it will be of a clear pale yellow colour; if well scutched, it will be silky in texture, and perfectly cleared from every portion of the stalk and other rubbish, the presence of which would detract from its value.

On the Continent, scutching is invariably performed by hand; but in Ireland, the growers, after having steeped their flax at home, often send it to some scutching-mill to be dressed. In the north of Ireland there are several of these mills driven by water, and in the south mills are being erected through the intervention of the Flax Improvement Society; but hand-scutching causes less waste, and if well performed cleanses the fibre more effectually.

In hand-scutching, the only apparatus required is a swingle or scutching-tool made of some tough wood, a small iron scraper, and a board 4 feet long fixed upright in a stand, having a slit or opening on one side into which the scutcher slips the flax, grasping it firmly with his left hand, whilst with the swingle held in the right he quickly and sharply strikes it downwards, turning and working it at the same time until it is soft and silky, and entirely freed from the stalks and other impurities. Hand-scutching affords a good deal of employment, and is performed with great rapidity by persons accustomed to the work, which, like every other branch of flax-management, is easily learnt, quickness and attention being the chief requisites.

Several kinds of scutching-mills have been invented, and they

certainly facilitate the process, and render it both cheaper and quicker; but they occasion more waste, and on the whole, if there be a sufficiency of hands for the purpose, hand-scutching is I think to be preferred to every other mode, especially where the quantity is not very considerable. In Ireland, notwithstanding the existence of mills, so important is hand-scutching deemed, that the Irish Flax Improvement Society have instituted a school for teaching the practice, under the superintendence of one of their chief instructors. They also furnish scutching-tools of the most approved construction, and send trained instructors into the several districts to teach the people—an example worthy of being followed in this country.

With scutching the process of preparation is completed, and the flax is then laid by ready for the market, each bundle being slightly twisted to keep it distinct, and prevent the fibre tangling. It is always important, with a view to the price, that flax of different lengths and different qualities should as far as possible be kept separate; for if indiscriminately mixed, it will not sell for so much as if it were divided into distinct lots of equal length and quality.

The farmer may select his own time for disposing of his flax. Should no market be conveniently near, factors or agents will find him out, and be ready to purchase his flax, as they now purchase his wool; so that he need give himself little concern about selling, provided the article be of good quality, for such will always be in demand.

The course of management just described, is the one most approved of wherever flax is most successfully cultivated. It is the mode practised in Belgium, where flax is generally kept till the second, and sometimes till the third year before it is steeped, and is considered to be improved both in colour and quality by keeping. It is likewise the mode generally practised in Holland, and is becoming more and more practised in Ireland, under the auspices of the Flax Improvement Society.

The management of the little flax hitherto grown in England, has been for the most part so imperfect and void of system, as to make it difficult to say exactly what has been the prevalent practice; but it is certain that here, as in Ireland, and to some extent even in Holland and Germany, growers have been accustomed, immediately the flax is pulled, to throw it into the steeping-holes with the seed on, and to complete the other processes forthwith, so as to get it to market as speedily as possible.

Now there can be no doubt that good flax may be obtained by steeping green; and by sending it to market the year it is grown,

the farmer obtains the benefit of a quicker return: but having regard to all the circumstances connected with flax culture, it is certain that for general practice the advantage lies decidedly with the method just described—that is to say, in drying or harvesting the flax when pulled, and stacking it ready for after-preparation, as opportunity serves. Both the flax and the seed are improved by this treatment, and the steeping and subsequent operations may then, as stated before, be performed at a time when little farm-work is in hand, and when it becomes especially important to find employment for the people.

As, however, steeping green, and preparing the flax for market immediately, may nevertheless be found convenient or necessary in some cases, I will now describe the mode of proceeding in this respect.

Let it then be assumed that the flax has just been pulled, and the long and the short lengths kept separate, the root-ends of one handful laid opposite the bolls of the other. The next step is

Rippling.—This is the act of separating the seed capsules or bolls from the stalk, and is done in the field immediately after the flax is pulled. The ripple is a simple implement, consisting of a row of iron spikes 18 inches long, screwed or fixed in a block of wood about a quarter of an inch apart, and spreading out at top to the width of about half an inch. This is secured on the middle of a plank 9 feet long, to be placed on two stools, so that two ripplers may sit astride, one at each end, with the ripple between them. A large winnowing-sheet must be spread under, to receive the bolls.

All being ready, the flax is handed by women or children to the ripplers, and placed conveniently at the right hand of each. The rippler takes the handfuls so placed in succession, spreads the top out like a fan, draws first one half of it and then the other through the teeth of the ripple, and thus separates the seed bolls, which fall on the sheet below. He then lays the handfuls down on his left side, where they are tied up in small sheaves or beets, ready for removal to the steep-pool.

The bolls thus separated, must be carefully dried, in the field if the weather be favourable, or else spread out thin in a barn or loft. In either case they must be frequently turned until perfectly dry, and then the seed must be sifted and separated from the chaff for future use. The chaff should likewise be preserved, it being, like the chaff of corn, highly useful for feeding purposes.

The seed being separated by rippling, and the flax tied up neat and even in small sheaves or beets, of equal size, it is next to be carried to the steeping-pool. This should be done the day

it is pulled if possible, or the day following at latest, especially if the weather be bright and dry; for the sun is apt to produce a discoloration of the green flax, which steeping and bleaching will not afterwards remove.

The process of steeping green flax is in all respects the same as when it has been dried, and the directions already given under this head apply equally to each, as they do likewise to all the subsequent stages of spreading, lifting, breaking, and scutching, and they need not therefore be here repeated. It may however be remarked that the water from the steep-pool, especially if the flax be steeped green, constitutes a valuable manure either for grass or arable land, and should not be allowed to run to waste if it can possibly be prevented.

Reference has been made to the peculiarly fine flax which the Flemings raise for the purpose of making their fine lace and cambric. This delicacy of fibre is obtained by sowing very thick, pulling early, rippling the seed, and steeping green. The quantity of this description of flax required is, however, comparatively trifling, and need not therefore be further dwelt upon, than merely to state, that by similar treatment a fibre of as great fineness and delicacy may be obtained in this country as is now produced in Belgium. Very thick sowing and early pulling, however, necessarily involve a sacrifice of the seed, which would be an important consideration if the practice were to obtain to any considerable extent; but this is not likely, for the reason above given.

There is yet another way of preparing the flax, much resorted to in the West of England, which ought to be noticed. It is called

Dew-Retting, or Dew-Ripening.—By this process steeping is altogether dispensed with, instead of which, the flax-stalks are spread thinly on the grass, and allowed to remain (being turned every three or four days) until the moisture from the earth and the action of the atmosphere have decomposed the vegetable matter connecting the fibre and the stalk, and thus allow of their being easily separated. Dew-retting is generally practised by the flax-growers in Somersetshire,* and is in fact equivalent to steeping, but the process is slower, and the flax so prepared is generally much stained, and suited only for the coarser purposes, and commands a proportionally low price in the market.

A meadow is best for the purpose of dew-retting, there being more moisture than on high land. The flax may be spread at any

* I have inserted in Appendices B and C (pages 470 and 471), two statements of the mode of cultivation pursued in Somersetshire, which I obtained from two intelligent practical farmers resident in that county; and it will be useful to compare these statements with the directions herein given for the management of the flax crop.

season, and snow has a very beneficial effect in ripening it. The grass on which the flax has been spread grows with great luxuriance afterwards, which may be an object of some importance to the farmer. The test for knowing when the flax has been sufficiently dew-retted, is the same as for ascertaining when it has been sufficiently steeped and grassed—namely, when the woody part of the stalk separates easily from the fibre—it is then fitted for breaking, and may either be stacked, or be broken and scutched immediately, at the option of the grower, all the processes being precisely the same as those already described.

Before concluding this portion of the subject, I will venture to give an estimate of the value to the grower of an acre of flax; for although any such estimate must at best be uncertain, depending as it does upon variable contingencies, it may nevertheless not be without its use in this place.

The produce of flax per acre, under a good system of cultivation, is generally found to be from 40 to 50 stone, although 60 stone is not unfrequently obtained, and this quantity has in several instances been grown in Norfolk within the last few years. Forty stone per acre may therefore, I think, be assumed as a safe average. The price for flax of average quality may fairly be taken at 7*s.* 6*d.* per stone of 14 lbs., but that of the finer qualities is much higher. The general yield of seed per acre is from 16 to 24 bushels, but it sometimes rises to 30 bushels, and 20 bushels may therefore be taken as a moderate average. The price of linseed varies from 8*s.* to 10*s.* per bushel for the finest sorts for sowing, to 6*s.* and 7*s.* for the common kind, such as is used for crushing and cattle-feeding, and 7*s.* per bushel may therefore be assumed as a fair average. Against these estimations must be placed the rent of the land, and the charges of cultivation and preparing the fibre for market. The account for an acre of flax will then stand as follows:—

Payments.	£.	*s.*	*d.*
Rent, rates, and taxes, say	1	10	0
2½ bushels of seed, at 9*s.*	1	2	6
Tillage	1	0	0
Pulling, steeping, &c.	1	10	0
Beetling 20 bushels seed, at 1*s.* and re-tying the flax	1	0	0
Breaking and scutching 40 stone, at 2*s.* per stone	4	0	0
	£10	2	6

Receipts.	£.	*s.*	*d.*
40 stone of flax,* at 7*s.* 6*d.*	15	0	0
20 bushels of seed, at 7*s.*	7	0	0
Chaff, refuse flax, and tow	0	10	0
	22	10	0
Deduct outlay	10	2	6
Leaving a balance in favour of the grower of	£12	7	6

* In last October Mr. Warnes sold, in the open market at Leeds, the whole of his flax raised and prepared at Trimingham, and obtained 85*s.*

This may be considered a large profit from one acre of land, perhaps too large to be reckoned on for a certainty, or for a permanence; yet higher estimates are given, even as much as 28*l.* and 30*l.* per acre. Other estimates have, no doubt, been given lower, some considerably lower; but, looking to the defective management on which these were founded, they can hardly apply to the improved system which it is the object of this article to recommend. Making every allowance, therefore, for unfavourable seasons, and the other contingencies to which flax-growing, in common with all other agricultural operations is subject, a profit of 10*l.* or 12*l.* per acre may, I think, be reasonably expected by the grower of flax, provided he attends properly to the business, and makes the most of the fibre and the seed.

In corroboration of this estimate, I insert the following statement by Mr. Samuel Druce, of Ensham, near Oxford, of the outlay and returns upon 4 acres 1 rood and 24 perches of land cultivated with flax under his management.*

Outlay.

				£.	s.	d.
Rent and taxes				11	0	0
Ploughing 4 A. 1 R. 24 P. at 10*s.* per acre				2	4	0
10½ bushels seed, at 7*s.* 6*d.* .				3	18	9
Sowing, harrowing, and weeding				1	12	0
Pulling, tying, thrashing, spreading, and preparing for scutching, at 30*s.* per acre . .				6	12	0
Carting and stacking				1	15	0
1455 lbs. flax scutched, at 2*d.* per lb. .	£12	2	6			
372 lbs. tow scutched, at 1*d.* per lb. . .	1	11	0			
				13	13	6
				£40	15	3

Returns.

	£.	s.	d.
1349 lbs. flax, sold by Mr. Schwan, deducting expenses	25	10	6
106 lbs. flax, sold in Ensham	2	13	0
372 lbs. tow, do. do.	4	13	0
104 bushels seed, worth in the market 7*s.* 6*d.* per bushel .	39	0	0
Tail linseed, and chaff and refuse, after scutching . .	1	10	0
	73	6	6
Deduct outlay	40	15	3
Profit on 4 A. 1 R. 24 P., being at the rate of about 8*l.* per acre	£32	11	3

This appears to be a detailed statement of the actual payments and receipts, and although it shows a less profit per acre than we have estimated above, it yet comes sufficiently near to be cited as a kind of corroboration. Mr. Druce describes himself as a "young beginner in flax culture," and it is certain that the quantity which he obtained per acre (viz., 23 stone) is little more than half the average produce. His flax is moreover described as being of very inferior quality, which, indeed, is proved by the low price it

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per cwt. for the finest sort, 70*s.* for the second quality, 65*s.* for the third, and 53*s.* for the coarsest. This last thus fetched 5*s.* 7*d.* per stone, and the finest kind 10*s.* 7½*d.* per stone; and it would have fetched considerably more, the quality of the fibre being much approved, but that it was defective in colour, owing to imperfect management in steeping, an error that will be avoided in future.

* See 'The Wiltshire Independent' of February 4, 1847.

fetched, that is, only about 5*s*. per stone. With better cultivation and better management, there can be no doubt that Mr. Druce will obtain better crops and secure higher prices, and his returns will then be proportionally increased.

3. *Preservation and Use of the Seed.*

The importance of preserving the seed, has been already adverted to in the first part of this article; and the mode of separating it from the stalk, by thrashing or beetling when the flax is dry, or by rippling when it is green (the former being, however, in all respects the preferable mode), has been explained in the second part. On these points, therefore, it is only necessary further to add, that the seed must be kept dry, and treated like any other grain.

The great value of flax-seed, as a constituent portion of the crop, cannot be too strongly impressed upon the cultivator. It is in fact the element, by the preservation and right use of which, flax culture will not only be rendered profitable in itself, but may be made conducive to an increased production of other crops, both grain and green, by the supply of valuable manure which it will afford.

At one time little care was taken in this country to preserve the seed, and it was often altogether neglected, and thrown into the steep-hole with the flax stalks: whilst in Ireland it was common, even recently, to see the seed rotting in the steep-pool, or floating along in streams by the roadside. This I have often witnessed, and as often endeavoured, with more or less success, to convince the peasantry of the wasteful folly of the practice. Since the establishment of the Irish Flax Improvement Society however, there has been a marked alteration in this respect; and I do not despair of seeing the Irish cultivators as careful in the preservation of the seed, as under the tutelage of the Society they are now becoming in the management of the other portions of the flax crop.

The great importance attached to the seed by the flax-growers on the Continent is well known, and the large quantities annually imported from Holland, Belgium, Germany, and Russia, prove its value in this country.* As flax cultivation extends, our home-grown seed will no doubt be purchased by the oil-pressers, for whose purpose it must be at least as good as the foreign seed; but if the farmer, instead of selling his seed, shall find it more advantageous to apply the seed grown on his own farm to fattening his own cattle, the oil-pressers will continue to obtain foreign seed

* See page 441.

for their purpose as at present; and after the oil is expressed, the residuum in the shape of oil-cake will likewise, as at present, be found a valuable addition to the farmer's store for winter feeding.

The use of linseed may therefore be considered as established, and its value certain; and if to the uses to which it has been hitherto applied be added a new use, or a material enlargement of one heretofore but little practised, an increased demand for the article will be created, up to the limit to which the new use extends; and unless there be a proportionate increase of supply, the market value will doubtless be enhanced.

Now linseed has hitherto been little used for general feeding purposes. It has, indeed, been rather extensively used for fattening calves, but the quantity required for this particular object is not considerable. Farmers were not, however, altogether ignorant of the fattening qualities of the seed, and a few of them here and there applied it to cattle-feeding, but never systematically, and as an essential part of agricultural management. Flax-seed thus continued to be used in a small way for feeding calves, and to a trifling extent in a few districts for fattening cattle, until Mr. Warnes established his system of box-feeding at Trimingham, and called attention to the subject by his several publications, since which the use of the seed for feeding purposes has been rapidly extending.

I visited Trimingham last autumn, for the purpose of inquiring into the mode of management adopted by Mr. Warnes. He had previously explained his system of cattle-feeding very fully in a work which he had published,* and I likewise received various explanations from him personally; but an inspection of the premises, and an examination of the management in all its details, appeared necessary for forming a judgment of the system.

Instead of being tied up in sheds or stalls of the usual form, the cattle at Trimingham are kept in boxes of from 8 to 10 feet square, very similar to horse-boxes, and in which the animals moved about with ease and freedom. In these boxes they are fed, and here they remain, from the time they are put up until they are ready for the butcher, which rarely exceeds six months, and is often less. Two sets are thus fattened in the course of the year, the feeding being continued winter and summer. Each box is sunk two feet, and forms a kind of tank at bottom, in which the manure is allowed to accumulate, fresh litter being added from time to time, as the bedding becomes wet or soiled. All the dung and urine are thus absorbed by, and mingled with the litter, which is trodden into a solid compact mass by the animal, so that no portion is lost by evaporation or otherwise.

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* Warnes on the Flax Crop and uses of the Seed, 1846.

The animals did not seem to suffer in any way from standing continually on this accumulation of manure. They appeared sleek and healthy, and evidently in a thriving condition; and as far as I could judge from what I saw, and from all that I learnt by inquiries on the spot, the boxes appeared to answer perfectly with respect to the cattle, whilst the manure obtained by this method is unquestionably great, and I believe superior in quality to that obtained by stall-feeding in the usual manner, all the excrementitious matter, both liquid and solid, being preserved.

The important distinction, however, between the mode of feeding at Trimingham and that usually practised, consists in the large and systematic use of linseed, which is, in fact, the foundation of the system. The seed is ground into a fine meal, and is then put into boiling water, and becomes a rich mucilage; in which state it is mingled in certain proportions with grass, clover, hay, and pea or bean haulm cut into chaff, or with barley, or pea or bean meal, or with turnips, mangold-wurzel, potatoes, or carrots steamed or boiled. The cattle are fond of these compounds, which are all highly nutritious, and are moreover one or more, if not all of them, obtainable in all seasons, so that the feeding can be carried on continuously throughout the year, which is an important consideration for the farmer. The animals fatten rapidly, and statements were exhibited to me, showing that by the use of these compounds cattle are fattened sooner, and at a considerably less cost, than by the usual mode of feeding.

It does not exactly come within the limits assigned to this article to describe in all its details, as I should otherwise be prepared to do, the system of box-feeding with linseed compounds, as it has been established at Trimingham, or to compare it with the old system of house-feeding so generally practised. Each will have its advocates, although each can hardly be equally advantageous to the farmer; and there cannot, I think, well be at this time a question of greater importance to the agricultural interest, than to ascertain by actual experiment to which system the preference ought to be given.

In the absence of such specific inquiry, I can now only advert in general terms to the fattening properties of linseed, and recommend its extended use by our farmers, and an extended cultivation of flax, not for the fibre only, but in order to obtain a supply of home-grown seed.

The use of oil-cake in feeding cattle has long been known, and the quantity imported,* added to the probably still greater quan-

* See page 443.

tity obtained from the oil-pressers in this country, shows the estimation in which it is deservedly held. But if the oil-cake is found so valuable for feeding purposes, we can hardly doubt that the linseed itself will be more so, the cake consisting of little more than the husks, after the oil has been expressed, that is, after the most nourishing portion of the seed has been abstracted; yet this refuse is found highly nutritious for cattle, which fatten on it very rapidly.

It has indeed been doubted whether the cake will not answer better than the seed, on account of the latter being so rich as to be apt to disagree with the cattle, if given in any quantity. There might be ground for this objection if the seed were given singly, but this is never done. As before mentioned, it is reduced to a state of mucilage, and mingled with other substances: and the compound may be made more or less rich by adding more or less of the mucilage, which it will be necessary to give in small quantities at first, in order to bring the cattle gradually to the use of a richer description of food than that to which they have been accustomed.

In whatever form applied, however, the linseed would still be the chief fattening ingredient; and its extended use, conjointly with an extension of house-feeding, would enable the farmer to fatten more cattle, and, as a necessary consequence, to obtain larger and better crops from his land.

It is a common saying among farmers that nothing is gained by cattle-feeding, although the old maxim, that "muck is the mother of money," is, I believe, a universally admitted truth; but how can "muck" be obtained without cattle-feeding? The whole runs in sequence—the more stock, the more manure—the more manure, the more produce—the more produce, the more money; and the thing to be aimed at is, so to adjust the working of this sequence, as to give the best return upon each branch of it, and the largest return upon the whole.

Now, having regard to the fattening qualities of linseed, there can, I think, scarcely be a doubt that the best results in all these respects may be obtained, by an extended use of this seed in feeding cattle; and if by its use, then surely by its growth; for in addition to the advantages that would accrue from thus using the seed, the farmer would have the benefit of the flax, a highly valuable commodity in itself, and most valuable as affording increased means of employment for the labouring population.

To enable the farmer to derive the full advantage from this use of the seed, however, it is obviously necessary that he should adopt house-feeding, either in stalls or boxes, as a regular portion of farm-management. Without this, his cattle would obtain less

advantage than they ought from the use of the seed, and he would obtain a comparatively small increase of manure.

In Belgium, house-feeding is universal; cattle of any kind are rarely seen in the field; and hence the small Belgian farmer, with very restricted means, is enabled to raise abundant crops, and to keep the whole of his land under constant cultivation. Without house-feeding this could not be done, for there would not be manure to sustain such a constant course of cropping; but by feeding his cattle of every description in the house, and carefully preserving every portion of excrementitious matter, both liquid and solid, the Belgian farmer obtains a sufficiency of manure for renovating his land, and is thus enabled to obtain a large amount of produce from a very limited extent of surface.

It would be well if the English farmer would follow the example of the Flemish farmer in this respect. I do not mean that the Flemish system, in all its details, should be entirely adopted by us; for under the circumstances existing in this country, it would probably be found impracticable: but our farmers might certainly feed much more stock than they do at present, by adopting house-feeding more extensively, and by the use of linseed in combination with grass, turnips, hay, and other substances. This would enable them to fatten more cattle at a less cost, and they would obtain sufficient manure for keeping more land under crop, and would thus secure a greater produce.

No one will deny that the best mode of feeding is that which fattens quickest and at the least cost, and which gives the largest supply of the best manure; and in all these respects house-feeding is decidedly to be preferred. If the stalls or boxes are properly prepared, the cattle will be protected from the effects of changes in the atmosphere, and be kept in a state of repose and comfort; whilst in the field they are exposed to sun, wind, and rain, to perpetual torment from flies and insects, and to constant effort and irritation, which greatly retard their fattening, and the manure is nearly or altogether lost. Even in the fold-yard cattle suffer from these causes, although in a less degree; but in boxes, such as I saw at Trimingham, the animals are protected from every annoyance and make progress accordingly.

It has been said on good authority, that the grass which would feed one bullock in the field, will feed three if cut and given to the animals in the house. This affords a strong argument in favour of box or stall-feeding generally, and is very important as regards the use of linseed, which requires to be given in combination with grass and other substances; and this can be done, as before stated, with the greatest advantage in the house.

I have thus endeavoured, in the terms prescribed by the Society, to state the reasons "in favour of extending the growth of flax in this country," and to explain the "most approved method of cultivating the plant," and "preparing the flax for market." I have likewise shown that the seed may be preserved without injury to the fibre, and have endeavoured to point out the way in which "the seed may be most profitably applied by the farmer;" and if the directions herein given be judiciously carried out, the result under each of these heads can, I think, hardly fail of proving satisfactory.

It must, nevertheless, be admitted that written directions, however accurate and precise, are not the most perfect guides in matters of this nature, neither are they always sufficient without other aid. Some instruction in a practical form is frequently necessary for giving a practical knowledge of subjects like the present, and this can only be imparted by practical teachers.

The Irish Flax Improvement Society were aware of this, and resorted to the only remedy, by employing trained instructors. These, in the first instance, they obtained from Belgium, and afterwards they sent young men to that country to be instructed in all the operations connected with the growth and preparation of flax, who on their return instructed others; and the consequence of this proceeding is, that not only has the quantity grown in Ireland been greatly increased, so as in 1845 to amount to the estimated value of 1,750,000*l.*;* but Irish flax, instead of being as heretofore coarse and inferior, has, within the last six years, become equal in quality to the Belgian flax, excepting perhaps the very finest sort, of which only a comparatively small quantity is required.

I found that Mr. Warnes had acted on the same principle as the Irish Society, having engaged two Belgians to superintend his flax operations at Trimingham. These appeared sensible intelligent men, perfectly skilled in their vocation; and, in addition to going out to the neighbouring farmers and others requiring their assistance, they have instructed a number of youths and young men, and fitted them for becoming teachers. This may be sufficient, as far as that particular district is concerned; but to ensure an early and general extension of the system throughout England, some more general and combined effort will probably be required; and if this be adopted, we may reasonably hope that it will be attended with like success.

* See the Society's Reports for 1845 and 1846. By the last Report it appears that twenty-six instructors are employed by the Society, to advise and assist the people in the management of their flax crops in every part of Ireland

APPENDIX A.

Referred to at page 448.

The following Rotations will serve to show the way in which the flax may be included in the course of cropping, and they may be varied or combined according to circumstances:—

A Four Years' Rotation.—1st year, wheat; 2nd year, turnips; a portion more or less, according to circumstances, being appropriated to flax, with a chance in favourable seasons, of obtaining a late crop of turnips after the flax has been pulled; 3rd year, barley or oats, with clover-seeds; 4th year, clover-hay; then the rotation commences again. This gives a quicker return of each kind than is generally desirable; but the flax crop may be varied by taking a different part of the turnip land at each return; and potatoes, carrots, or mangold-wurzel may be occasionally introduced, so as to give a greater variety without departing from the general rotation.

A Five Years' Rotation.—1st year, wheat manured; 2nd year, flax; 3rd year, turnips, potatoes, or mangold-wurzel manured; 4th year, barley or oats, with clover and grass-seeds; 5th year, hay; and then the rotation again commences. This gives a sufficiently quick return for flax or any other crop; and it may be stated as a general rule, that the more varied the rotation, and the longer the interval between the same description of crop, the better will it be for the land and the better will be the produce.

A Six Years' Rotation.—1st year, turnips, potatoes, or mangold-wurzel manured; 2nd year, barley or oats with clover-seeds; 3rd year, clover hay; 4th year, flax, with or without a slight dash of manure according to the strength of the land; 5th year, wheat manured, and the flax having been pulled in July gives half a summer fallow for the wheat; 6th year, barley or oats. Neither of the foregoing rotations include peas or beans, which may, however, be introduced so as to prolong each of the courses a year.

The following *Six Years' Rotation* has been found to answer well in Ireland, viz., 1st year, potatoes, turnips, or mangold-wurzel manured; 2nd year, wheat or oats; 3rd year, flax with clover and grass-seeds sown therewith; 4th year, clover hay; 5th year, grass; 6th year, oats or wheat.

It is, however, a disputed point whether clover should be sown with flax, and conflicting opinions for and against have been urged; but it is admitted on all hands that clover does well after flax, the early pulling loosening the soil and encouraging the growth of the clover. As far as I have been able to ascertain, there is no well-grounded objection to the practice; but on this point, as on all others, experience is the only sure guide, and the best course will be to try it in a small way at first. If it succeeds, persevere—if otherwise, abandon the practice.

A Seven Years' Rotation.—1st year, turnips manured; 2nd year, wheat; 3rd year, flax half-manured as for wheat; 4th year, barley, with clover and grass-seeds; 5th year, clover hay; 6th year, beans or peas; 7th year, wheat or oats; and then the same rotation over again. This

would give two wheat crops in seven years, and requires good land and liberal management.

An Eight Years' Rotation.—1st year, turnips manured; 2nd year, wheat; 3rd year, flax lightly manured; 4th year, barley and seeds; 5th year, clover hay; 6th year, grass; 7th year, peas or beans, manured more or less according to the nature of the land; 8th year, oats; and then the rotation commences again.

APPENDIX B.

Referred to at page 460.

Observations on the Cultivation of Flax as practised in Somersetshire. By *— *— of S— P—.

Soil.—Flax requires a dry soil, either naturally or artificially. Loam, mild clay, stonebrash, and gravelly soils are well adapted for its growth, especially a good dry rich sandy loam; but whatever the soil flax is to be grown on, it must first be put in a high state of cultivation and freed from weeds to ensure success.

Preparation for the Seed.—Flax will succeed best after potatoes, wheat, or clover-leys, or perhaps best of all on newly broken-up maiden land. The land should be ploughed in the autumn, so as to lie all the winter exposed to the frost and the action of the atmosphere, by which slugs will be destroyed, which are some of its greatest enemies, and a good tilth ensured for the reception of the seed. The general practice amongst the best flax-growers is, either to fold the land with sheep at the rate of from 1800 to 2000 per statute acre, twice, one folding in the autumn before the first ploughing, and the other during the winter, or early in the spring if the weather permits, or one folding and from 25 to 30 yards of good compost of dung and earth. The land requires to be in a fine tilth, with a firm bottom, previously to receiving the seed.

Seed.—The usual practice is to obtain Riga seed in barrels of about 3 bushels each (when freed from dirt and seeds), which will be a sufficient quantity to sow an acre and a half; although some growers prefer sowing 9 pecks per statute acre. This seed may be sown three years, when it will be advisable to procure more "barrel seed," as it is provincially termed in this county. If, however, the seed is not changed about every three years, the flax plant will degenerate, which may be observed by its throwing out lateral shoots, and not attaining its former height. When this is the case, the stem will be coarse and the flax not of so good quality. The great desideratum to be aimed at in growing this plant is to get it tall and fine. The general custom is to sow the seed broadcast, about the first week in April, if the season will permit; I have known it sown as early as the last week in March, and as late as May, though seldom with success; but within the last four or five years a considerable quantity has been drilled at 6-inch intervals; and I am of opinion that this practice is increasing, as it affords greater facilities

for healing the seed, and of afterwards hoeing and weeding, much damage being frequently done to the young plants by the women and children trampling it for the latter purpose.

Harvesting.—The crop in ordinary seasons is ripe enough to be pulled about the middle of July, but the usual criterion of its being in a fit state for that purpose is the leaves having dropped off the stalks about 6 inches from the ground. It is then pulled, and either stripped of the seed-bolls at once in the field, or tied up in small sheaves, and carted off to some convenient place where the sheaves are again opened and spread thin for drying. They are afterwards tied up again, and removed to some convenient place for "stamping"—this is done on a dry dirt-floor, with a large wooden mallet, when the bolls are "stamped" off. The flax is then again tied up and ricked, where it remains until it is wanted for spreading, previously to "swingling;" or if intended to be immediately prepared for market, it is spread abroad on a piece of grass-land or stubble, where it remains (being turned over at intervals of about three days if wet weather, or it may remain a much longer time if dry) until it is in a fit state for "swingling," an operation for separating the fibre from the stalk, previously to which it is dried over a slow fire, which renders the operation more easy and perfect. It is then tied up in "dozens," which are bundles of 12 lbs. each, which is the last operation of the grower, and is then fit for the spinner. From forty to fifty dozens an acre is a good average crop, and is worth at the present time about 5*s.* 6*d.* per dozen.

It is not unusual to plough the land on which the flax grew immediately on the removal of the crop, and sow it with early turnip, rape, and in some instances mustard-seed, which will on an average of seasons be fit for feeding with sheep in about nine or ten weeks from the time of sowing. The feeding off the crop on the land with sheep being completed, the land is then immediately prepared for wheat, thus getting two crops off the land, and a third sown in the same year.

APPENDIX C.

Referred to at page 460.

The Management of Flax in Somersetshire.

By *— *— of Y—.

Flax requires a loamy soil, in good condition, well drained if previously inclined to be wet, and the principal thing to be attended to is to obtain as fine a texture as possible. For this purpose the land should be ploughed early, so as to expose it as much as possible to the action of the frosts and weather.

The best crop for flax to succeed is young grass; but in good land it answers well after stubbles, if previously well manured by folding with sheep, and this is generally the best manure for the growth of flax.

If the land be wet, it should by all means be drained, or the plant will probably be attacked by a disease called the rust, which eats through

the fibre, separating it into short lengths, and converting a great portion of it into tow in the after-process of manufacture.

In selecting the seed, the flax-grower should be particular to obtain that which has not grown in the same place more than three or four years, or he will probably find that the plant will have considerably degenerated from its general character. If the seed be good, the plant will grow erect and clean in the stalk; but if, on the contrary, the seed be from a plant which is degenerate, the stalk will abound in small branches, or become, as it is called, "sprigged." It is therefore advisable to change the seed every three or four years; but whether this change be effected by the use of foreign seed, or by the use of English seed from a distance, does not appear to be material. The seed most preferred is that which has been sown one year in the place intended to grow it. The seed should be thoroughly cleaned by the use of sieves made for that purpose, and be sown broadcast at the rate of about 2 bushels to the acre. It is occasionally drilled, but there does not appear to be much advantage in adopting that plan, as the ground should be covered by the plants. The best time for sowing flax is between the last week in March and the first week in April. It may, however, be sown as early as the first week in March, or much later than the first week in April; but the time first mentioned is to be preferred, if the state of the land and the weather should permit. The plant is not killed by moderate frosts; but if subjected to much of such weather, it becomes too much checked in its growth to recover its proper strength.

In considering the most proper time for harvesting a flax crop, it is to be first determined whether the crop of fibre or of seed is to receive the most attention. If the former be the chief object, then the plant cannot be pulled too young, if full grown; but if the latter be most required, then it should remain on the ground until perfectly ripe. The custom in this county generally is, to secure as nearly as possible an equal share of these two advantages; and in order to do this, the plant should be pulled when the leaves about the lower end of the stalk begin to fall off, and this will take place about the second or third week in July. It may, however, be necessary to harvest the plant before this, as for instance if it be much laid, or if attacked by the rust before alluded to. In the latter case it will always be desirable to pull it early, and this is most likely to occur in damp places or in wet seasons.

The flax, having been harvested, is spread out to dry, the seed then stamped out, and the flax subsequently spread out in order to prepare it for the operation of swingling. The best land to spread the flax upon is a stubble field; grass-land is very commonly used, but in such case the fibre is most likely to be injured by worms. Some experience is required to determine when the flax is ready for the operation of swingling. It should be in such a state that the skin will break easily from the interior fibre. If it remains out too long in wet weather, it is likely to rot and yield a disproportionate quantity of tow; but if it does not remain out a sufficient time, the flax will not readily separate from the outward coating. It would certainly be better to thrash and spread it out in the long days, there being then a greater

chance of carrying it dry; but as this happens at a busy time of the year it is seldom done.

The best flax in this county is grown in the neighbourhood of Wellington. It is known in the market as Taunton flax, and will fetch from 5*s*. to 10*s*. per pack more than that grown in other parts of the county.

XX.—*On Box-feeding with Linseed Compounds.* By George Nicholls.

The general recommendations contained in the preceding article on Flax Culture, with respect to the application of the seed to feeding cattle, are all that seemed to come fairly within the limits prescribed for that subject; but the question is in itself of so much importance to the farmer, and is so intimately connected with the extension of flax cultivation in this country, that I have thought it right to prepare this additional article by way of continuation, in order that both may appear together, if honoured by acceptance.

In recommending house-feeding as a regular branch of farm management, I did not, in the article referred to, speak decidedly as to the particular mode, whether in sheds, stalls, or boxes. Each may possess certain advantages, and each may have its advocates; but it is only by extended observation and experiment, that the really preferable mode can be ascertained with such certainty, as to warrant its being recommended for general adoption in preference to all others.

In order to obtain information on this point, I last summer visited Trimingham, where I understood a system of cattle feeding had been adopted by Mr. Warnes, comprising a liberal use of flax-seed in conjunction with other farm produce; and having carefully examined and inquired into all the details of the system of box-feeding there established, I felt it impossible to doubt its efficiency at least, if not its actual superiority over every other mode heretofore practised—that is, superior as regards the cattle, superior with respect to the quantity of the manure, and superior as affording the best and most economical mode of fattening of stock. This system I will now describe.

On my arrival at Trimingham, I found thirty bullocks put up in the boxes for fattening. They were of a mixed character, mostly of the short-horned or polled kinds, some Scotch, some Irish, and some home bred. Several of the animals were nearly fit for the butcher, others in various stages of forwardness, and some had only just been taken up. These last were kept upon cut

grass without linseed, it being necessary to bring them gradually to a richer description of food. A constant succession is thus maintained, lean beasts coming in as the fattened animals are taken off, generally within six months of their being first put up; and thus the boxes are never empty.

Nothing can be more comfortable in appearance than the animals which had been up some time. They had become accustomed to their boxes, were protected from every annoyance arising from heat or cold, the weather or insects, were kindly treated, and appeared the very pictures of animal enjoyment. On entering the boxes, instead of being shy or alarmed, they approached and solicited attention, and seemed pleased at being scratched and handled. Their eyes were bright and clear, their coats sleek and glossy, scarcely a speck of dirt or soil could be seen on any of them, although each moved about unrestrainedly in its box. Some were eating the compound of cut grass and linseed, some were lying down ruminating their food, some sleeping, but all evidently in thriving condition, and partaking of a joyous existence.

The contrast between these animals, and a number of feeding beasts which I afterwards saw in a large field adjoining part of Mr. Warnes's farm, was most striking. The weather was hot and the gadfly troublesome, and these poor beasts were running and racing about to escape from the enemy, worried and heated, and in a state of great irritation and discomfort. In the boxes the animals were screened from the sun, protected from flies, and in the enjoyment of perfect quiet and repose, so essential for fattening; whereas in the field the cattle were in a constant state of effort and excitement, preventing the development of flesh or fat. In the boxes the dung and urine are preserved, mingling with the bedding, and forming a most valuable manure, always available for application to the land. In the field the dung and urine are for the most part lost, the finer particles being washed away by rain, or carried off by the atmosphere. How widely different must the results be to the farmer in these two cases, especially when tested on a large scale!

If such be the advantages of box-feeding over feeding in the open field, it possesses advantages similar in kind, if not equal in degree, as contrasted with the fold-yard, where the stronger animals tyrannize over the weaker, driving them about and preventing their eating. Hence the inequality so frequently observed in the fattening of folded cattle; and hence, likewise, it is often seen, when some of the animals have been removed, that the others which did not thrive before, will fatten apace after being relieved from their oppressors.

All these evils are avoided in box-feeding. The animals are

protected from annoyance, and can feed and take their rest undisturbed, and each animal makes progress accordingly. The food is not wasted in the boxes, but in the yard much of it is trodden down and lost. If grass be cut and given to the cattle in the house, it is generally admitted that the quantity which then feeds three, would only feed one grazed in the field; and it may, perhaps, be said, that the food of one beast in the yard, will feed two in the boxes: besides which, there is, as before stated, a greater economy of manure.

Farmers commonly assert that nothing is to be gained by fattening cattle, and as it is now generally practised the saying may not be without some foundation; but is this absence of profit unavoidable?—might not the result be different, if a different mode of feeding were pursued?—This is an important question for the English agriculturist, and to this question the system of box-feeding established at Trimingham appears to afford a conclusive answer.

But it is not for the fattening of cattle alone that this system is to be commended—it likewise enables the farmer to obtain the largest amount of produce from his land—the two things, in fact, move together. By a regular system of box-feeding winter and summer, three times the quantity of stock may be kept, and kept profitably; and the more cattle the more manure; and the more manure the more produce. All other things being equal, this may be regarded as an invariable rule.

There is an old saying that "Muck is the mother of money." This is certainly true, and it is equally true that box-feeding is the mother of muck; for not only are the animals fattened in the least possible time, and at the least possible cost, but the largest quantity of manure, and that of the very best description, is in this way accumulated. The litter absorbs the excrementitious matter of every kind, so that nothing is lost; and the whole, if properly preserved and properly applied, will constitute the element of future fertility to the farmer. In this respect there is no country so favourably circumstanced as England, for in no other country does animal food enter so largely into the ordinary mode of living of the people, and here therefore the greatest amount of produce ought to be obtained.

The large quantity of fertilizing manure which is acquired by box-feeding, will enable the farmer to dispense with fallows and keep the whole of his land under crop, not only without exhausting it, but with an actual increase of its productive powers, provided a right rotation be observed, and that a due amount of labour be applied to its cultivation.

The mode of feeding which fattens quickest, and at the least cost, and which yields the largest quantity of manure, is unques-

tionably the best; and by extending flax culture, and applying the seed conjointly with other substances raised on the farm to box-feeding, the farmer will, I believe, be enabled to keep thrice the number of cattle, and to fatten them quicker and cheaper than in any other way, whilst he will at the same time secure a proportionably large supply of the very best manure for the purposes of his farm.

Oil-cake has long been extensively used for cattle-feeding by our English farmers, and on an average of the last four years 73,000 tons have been annually imported for this purpose.* The largest portion of the oil-cake used in this country, however, is obtained from the imported seed after the oil-pressers have extracted the oil: but in whichever way obtained, there can be no doubt that the use of oil-cake for fattening cattle is highly advantageous to the farmer; and this alone, if other argument were wanting, seems to indicate the expediency of resorting to home-grown seed for a like purpose. If oil-cake, which is merely the residuum, the husk and refuse of the seed after the oil has been expressed, is found thus profitable, can we doubt that the seed itself, before its fattening qualities are reduced by passing through the pressing-mill, will be equally if not more so?

It may possibly be said that the seed is too rich, too full of oleaginous matter, too fattening in short; and that the cake being less oily, less fattening, and more bulky, is not so likely to disagree with or derange the health of the animals. Food may, no doubt, be too rich for cattle, as well as for man; and bulk is necessary as well as nourishment in what is taken into the stomach; but wherever there is an excess of nourishing properties, how easy the remedy! We have only to dilute by mixing other materials less rich, less nourishing. In the present instance, ground linseed in the shape of mucilage is to be mixed with other substances the produce of the farm, namely—grass, clover hay, or pea and bean haulm, cut into chaff, or the chaff of corn and flax, or barley and pea and bean meal, or turnips, mangel-wurzel, carrots, cabbages and potatoes boiled or steamed. These materials compounded with the linseed, give bulk and substance as well as variety, and thus become the medium for imparting the largest amount of nourishment in a form most agreeable, most conducive to the animal's health, and best calculated to ensure its speedy fattening.

On these views the system of box-feeding established at Trimingham is founded. It combines shelter and comfort for the cattle, and a sufficiency of the most nourishing description of food, with the means of obtaining the largest quantity of the most fertilizing manure. This system I will now endeavour to explain;

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* See p. 443.

and the most convenient way of doing so will be, first to describe the several arrangements there in use, making such observations upon each as appear necessary; and then to describe the mode of feeding, with a like commentary.

1st. *The arrangements for Box-feeding.*

The cattle-boxes are roughly and cheaply formed, but they appear well calculated for their object. They are arranged on three sides of an old farm-yard, the fourth side being occupied by the barn; and in the centre of the quadrangle, facing the barn door, stands the *straw shed,* and near to it is the *pump.* The *cooking-house,* having two *iron boilers,* one of 50 the other of 30 gallons, is in one angle, accessible from all the boxes; and in another angle is the *forage-house,* in which stands the *chaff-cutting machine,* where clover, grass, hay, straw, and forage of all kinds, are cut into chaff ready for use. This likewise communicates with the cattle-boxes; and near it is the *root-house,* in which turnips, carrots, mangel-wurzel, or potatoes, are stored for use as required. The cooking, forage, and root-houses, are all formed out of old portions of the premises, which were previously used for other purposes, but they answer their present object perfectly. There is likewise a small room adjoining the cooking-house, in which stands the *crushing-machine,* for grinding or crushing the flax seed into fine meal.

The foregoing constitute the entire of the offices in connexion with the cattle-boxes, and nothing can be more simple and unpretending than the whole of the arrangements, or more obviously formed with a view to convenience and economy. The boxes themselves vary somewhat in size, but they are in general about $8\frac{1}{2}$ feet square, inside measure. Some of them, however, were 8 feet by 10. They are enclosed next the yard by a roughly-made double gate the whole width of the box. One half the gate moves on hinges, the other half is bolted to the frame-work; but both are readily opened for removing the manure, or any other purpose. At the inner end of the boxes, and running the length of the entire range, there is a passage about 3 feet wide for the convenience of feeding and attending to the cattle. This passage is separated from the stalls by the crib or trough in which the food is deposited, and which is capable of being raised or lowered for the animal's convenient feeding, according to the height of the bedding at bottom of the box.

The boxes standing in the same range are separated from each other by three rough rails, secured to the upright posts which support the roof; the space between the upper and middle rail being greater than between it and the lower, to allow of the bullocks putting their heads through when moving about the box, and thus to tread the bedding close to the rails, making the

whole of it solid and compact in every part, which prevents its heating.

Some of the boxes are formed as leantos against the stable-wall, which is 12 or 14 feet high, whilst the roof of others rests upon a part of the yard-wall 6 feet high. They are all sunk 2 feet below the surface; and each box thus forms a kind of tank, which is effected by excavating to the depth of a foot, and depositing the earth on the outside. The passage at the head or inner end of the boxes is not sunk, but remains at the natural level. A lining of stone or brick 4 inches thick surrounds the bottom of each box, on the angles of which upright posts 6 feet long are fixed, and on these the tye-beams and roofing rest, all being formed of rough spars of the cheapest description. The roof consists of thorns, gorse, and other rubbish, and is thatched with straw. The boxes are thus 8 feet high within, from the bottom to the tye-beam, which allows 6 feet in the clear, when the bedding by successive additions shall have risen to the level of the surface. When this is the case, the whole must be removed, and a little dry mould, sand, sawdust, ashes, or other absorbent, strewed upon the bottom, before fresh litter is supplied.

Such are the cattle-boxes in use at Trimingham, and similar ones may be formed with very little assistance by any farmer who gives his attention to the subject. Mr. Warnes estimates the cost of each box at 30*s*. This may seem a low estimate; but allow double, or even treble that sum, and it would still be worth the outlay.

No doubt more expensive, and, with respect to appearance, more complete structures might be raised; but it is doubtful whether they would answer the purpose better. A slated or tiled roof, and more space within, may seem preferable to a roof of faggots and thatch: but the latter is cooler for the cattle in summer, and warmer in winter; and 6 feet is sufficiently high, if a few open spaces for ventilation are left in the back wall, to be opened or closed as circumstances require. To protect the cattle from the sun and flies in summer, a screen of coarse canvas is hung on the outside, which effectually answers the purpose without excluding the air. The weather was oppressively hot when I inspected the boxes, yet I found them cool and shady, and the cattle in a state of perfect enjoyment.

The precise arrangement of the boxes and attached offices must of course depend in some measure upon the locality, an arrangement suitable to one place being probably unsuitable to another. In many instances, old existing buildings may be converted into cattle-boxes at a trifling cost; and wherever there are stalls or sheds, or spare out-buildings on a farm, they may thus be readily converted. In Belgium, where stall-feeding is universal, and

where cows or cattle are scarcely ever seen in the field, their farm-buildings are arranged in every variety of form, two essentials, however, being invariably attended to, namely—the comfort of the animals, and the preservation of every particle of manure, both liquid and solid; and these are the essentials to which our English farmers must attend, if they wish their cattle to thrive and their farms to be productive.

The straw-shed is an important part of the establishment in box-feeding, straw being required for litter, as well as occasionally for chaff in forming the compounds. The size of the straw-shed must depend on the size of the farm, and the number of cattle; but as the large quantity of rich manure obtained by box-feeding will enable the farmer to keep a considerably larger extent of land under tillage, the size of the shed should not be limited to the quantity of straw at present raised on the farm, but it ought to be sufficiently large to receive the additional quantity to be raised hereafter, under a better system of management.

The floor of the shed should be sunk 5 feet below the ground, and the sides walled up 3 feet above it, leaving a space at one angle for a door. This will economize space, and the straw may be more easily thrown in than if the shed were built on the surface. It will allow likewise of the straw being trodden down occasionally by a horse, to compress it into a smaller space, and the closer it is packed the better it will keep. Uprights 6 feet long are placed on the walls to support the roof, and the eaves should project well beyond the walls to throw off the rain. The shed will thus be 14 feet high from the bottom to the roof, and may be of such length and width as the farmer thinks fit.

The cooking, crushing, forage, and *root-houses* require no explanation, their names importing the uses to which they are respectively applied, and also indicating the most eligible size and situation for the several objects. The *crushing-machine* and the *chaff-cutting machine* may each be worked by horse, steam, or water-power, if such exists on the farm, or if it be deemed desirable to provide either for this or other objects.

The foregoing brief descriptions will, it is hoped, be sufficient for conveying a tolerably distinct notion of the premises and appliances required for box-feeding; and I will now, in like manner, describe the mode of feeding, and the general management to be observed.

2ndly. *The mode of feeding.*

Linseed must never be given to the cattle singly, nor without being first ground into meal. If given singly, it would be too rich

and oily, and apt to disagree with the animal; and if unground, much of the seed would pass through the intestines without being digested, and would consequently be useless towards fattening the animal. When ground and mixed with boiling water the linseed meal forms a rich mucilage, in which state it is mingled with other materials, forming a highly nutritious compound, of which in a short time cattle become extremely fond, and on which they are speedily and economically fattened.

The cattle-compound may be formed with any kind of farm produce, provided it contains a proper quantity of the linseed. If barley, beans, or pease be used, they must be first ground into meal; if grass, clover, hay, straw, or pea and bean haulm be used, they must be first cut into chaff; if turnips, carrots, mangel-wurzel, cabbages or potatoes are used, they must be first boiled or steamed; after which all or any of the above materials may be formed into the compound, the only implements required for making it being a couple of large tubs or half-hogsheads, three or four buckets, a wooden rammer, and a fork.

The compounds are essentially of three kinds:—1st. The corn and pulse compound. 2nd. The root compound. 3rd. The grass and chaff compound. These may all run into and mingle with each other, according to circumstances, but they constitute the three leading distinctions, under one or other of which all the cattle compounds may be classed; linseed being, however, in each the chief ingredient for fattening. I will now describe these compounds, and the mode of preparing each.

1st. *The Corn and Pulse Compound.*—A mixture of three parts of barley, oat, pea, or bean-meal, incorporated with one part of linseed meal, forms a most nourishing compound. The linseed-meal is to be first stirred into the requisite quantity of boiling-water, in the proportion of a pound of meal for a gallon of water, until it forms a mucilage. The barley, pea, or bean-meal should then be added, stirring it rapidly; and, as the mass cools, it may be given to the cattle either singly or together with other compounds, or with cut grass or turnips, according to the season. Bran, or the chaff of corn or flax, may be stirred into this compound if desired. These substances will add to its bulk and somewhat increase its nourishing qualities; and it may, therefore, at times be desirable by way of change to add them to the mass, but more water will then be required. This compound will keep for a week, or even longer, if properly prepared and rammed down close, so as to exclude the air and prevent its fermenting.

2nd. *The Root Compound.*—To form a compound with tur-

nips, carrots, mangel-wurzel, cabbage, or potatoes, the process is equally simple with the above. Clean the roots from dirt, and cut or slice the larger ones into moderately sized pieces; then put them into the boiler with one or two pails of water, according to its size and the quantity of materials. Cover the boiler close; and as the steam rises it will soon cook the roots, which are then to be removed, portions at a time, into a tub or trough placed at hand for the purpose, and there mashed with the rammer, a boy scattering the requisite quantity of linseed-meal over the smoking roots as they are mashed and turned, which thoroughly incorporates it with the mass. Proceed thus until the whole is prepared, and it should then be rammed down firmly in the tub, and smoothed over at top with a shovel or trowel, in order that it may retain its heat, and thus thoroughly incorporate the linseed-meal with the other ingredients. The tub or trough should have a stout bottom, to stand the action of the rammer.

3rd. *Grass and Chaff Compound.*—This is formed of clover, rye, or any other kind of grass; or of hay, straw, pea, or bean-haulm; or the chaff of corn and linseed, or all or any of them combined. Each of these materials possess more or less fattening qualities in themselves; but they act at the same time, and principally, as a useful medium for conveying the linseed-meal, the most fattening of all substances, into the stomach of the animal, and the effect of the compound thus becomes extremely beneficial.*

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* It is to be regretted that Mr. Nicholls does not give Mr. Warnes's experience as to the comparative advantage of using one or other of the above-mentioned compounds. Some very accurate experiments, made at the suggestion of the Highland Agricultural Society, and published in the 'Quarterly Journal of Agriculture,' make it appear that the expense of cooking turnips, or other roots, is not repaid by any corresponding improvement in the cattle fed with them, and my own experience quite agrees with these results. I should therefore venture to recommend to my brother feeders as a general rule, that turnips and other roots be given raw, and that the compound used for winter feeding, be chiefly made with cut straw or chaff (described above as Compound 3rd). The cheapest, and I think the best way of making this compound, is to mix it on a smooth brick floor immediately adjoining the pan or boiler in which the linseed mucilage is prepared. Upon this floor throw down the cut straw or chaff: mix with it whilst dry, the meal intended to be given: upon this heap, flattened at top, pour the mucilage by bucketsful: nothing more remains to be done, but to turn the heap over with a shovel. The partial cooking of the mixture by its own heat (mentioned above) is perfectly well effected in a heap such as I have described, if smoothed over with a shovel and left for half an hour before being served out to the cattle. The advantages of this mode of mixing are, that it is more quickly done; that there is scarcely any limit to the quantity of food that can be prepared without any additional utensils; and that a few minutes suffice to wash

The grass, clover, hay, and straw, must all be cut into chaff by the chaff-cutting machine; and the linseed mucilage is to be prepared by stirring the meal into the requisite quantity of boiling water, at the rate of a pound of meal to a gallon of water: or, in a larger way, at the rate of a pailful of the meal for every six pailsful of water. In a few minutes the mucilage will be formed, and a large tub being placed ready, a quantity of the chaff is put into it, and the linseed mucilage is then ladled over it, stirring and turning it quickly with a fork at the time. Then add more chaff and more mucilage, continuing to stir it as before, and ramming it down until the whole is mixed and formed into a compact mass. It must then be covered over close until it becomes partially cooked by its own heat, and when sufficiently cool it may be given to the cattle; if allowed to stand too long it is apt to turn sour, which the cattle dislike. In winter the animals like their food warm, and it is then probably more easy of digestion and more nourishing. Any kind of chaff or bran may be added to this compound, or it may be given alternately with the first or the second kinds, at the option of the farmer.

The quantity of these compounds to be given at one time will depend very much on the size and condition of the animals. It may, however, be laid down as a rule, that every feeding beast should be allowed as much as he can eat without injury to his general health, which must be attended to by the person in charge, and the animal's appearance will immediately indicate if anything is wrong. Another rule is, that the animal should be fed frequently, a little at a time, and often, which will prevent his hanging over or nauseating his food, and help materially towards improving his condition. He should also have a little clean straw frequently added to his bedding, which greatly conduces to his comfort; he will then lie down and ruminate as soon as he has eaten his food, and seldom rise but to eat again.

A compound, with rather less of the linseed mucilage, may be used with advantage for farm-horses. Mr. Warnes says,* "In

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the floor clean after each mixing. In tubs, the compound cannot be thoroughly mixed without a liberal use of the stirrer and rammer, and where there are many cattle, and consequently several tubs, the whole process of putting in successive layers, stirring and ramming, has to be repeated in each. Taking the compound out of the tubs also, after it has been rammed down tight (especially from near the bottom), is tedious compared with shovelling it up from a heap on the floor, and each tub must be washed or scraped very clean, otherwise the small fragments remaining turn sour, and give a disagreeable taste to the next mixing. In all the feeding establishments in Yorkshire that I am acquainted with, mixing on the floor is preferred to the use of tubs. H. S. Thompson.

* See Mr. Warnes's work on Flax, and the use of the Seed, pages 183 and 236.

April last my farm horses were fed with wheat-straw, cut into fine chaff, and immersed in boiling linseed-meal and water till all was absorbed; with this they worked ten hours a-day, and looked better than when fed on hay and corn." And one of his correspondents states :—" I am now feeding 14 horses and colts with straw and hay compound. My plan is, to 8 bushels of cut hay and 8 bushels of wheat-chaff are added 28lbs. of crushed linseed, boiled in 18 pails of water; I give the horses this quantity at night in the yard. In addition they have 1 pint of pea-meal per day, and 1 cwt. of straw per week; the boiling linseed is poured upon the chaff, and both are thoroughly mixed together. I intend giving my young stock $1\frac{1}{2}$lb. of linseed-meal with a bushel of chaff daily; my cows the same.

For sheep, a compound is recommended consisting of linseed-meal and barley, the latter pressed flat by a crushing-machine. The linseed mucilage is to be prepared as before directed: a pound of the meal for every gallon of water; then add 3 lbs. of the crushed barley for every pound of the linseed; the barley will shortly absorb the whole of the mucilage, and the grains will swell out to nearly their original size and shape. It may then be given to the sheep, which will eat it with avidity, and thrive upon it, as indeed they will upon any of the grass or chaff compounds.*

Every farmer ought to be careful of his straw, and should economize its use in winter, when so much is usually wasted in the fold-yards. It will be wanted either as bedding for his cattle, or, if other provender run short, for cutting into chaff to mix with hay and other materials in forming compounds in spring. The straw-shed will greatly help to preserve the straw, by keeping it dry; and if there be more straw than the shed will contain, it should be stacked and thatched, and be thus preserved until it is wanted for use.

Grass is more abundant in some seasons than in others, and the farmer may in some measure guard against a failure in the grass-crop, by having a piece of lucerne, more or less, according to the size of his farm, to fall back upon in case of need. Lucerne thrives best on a dry deep soil, and if it be kept clean and well manured, it will give four good crops in the year. It is perennial, and will last many years, if properly managed; and is likewise of hardy growth, and well calculated for the small farmer. Cattle are fond of it, and it answers as well for compounds as either grass or clover.

There is nothing intricate in the foregoing directions. Nothing

* See Mr. Warnes's work on Flax, and the use of the Seed, p. 122.

difficult in the preparation of the compounds or in the mode of feeding the cattle. The whole is quite simple, and will be easy to manage when once understood. The amount of labour likewise is less than might be inferred, from reading the directions, the minuteness of which make them appear rather burthensome: but method and regularity are, in truth, the chief requisites; in proof of which, it need only be mentioned, that the cattle-boxes at Trimingham are in the charge of an elderly man, with the assistance of a boy. The man is blind, but he has acquired a perfect knowledge of every beast, and can tell by handling the progress each is making; he moves about the passages from one box to another without being ever at a loss, and the animals know him and come to him and solicit his attention, showing how perfectly they are become domesticated by kind treatment.

The grass-compound was being used when I visited Trimingham; the grass having been cut and carted home in the usual manner, and deposited in the forage-house. It is there cut by the blind man just mentioned, who worked the chaff-cutting machine very expeditiously, and cut a considerable quantity whilst I was present. When thus cut, the grass is compounded with the linseed-mucilage in the way I have described, and I saw the cattle eating it with great avidity. The addition now and then of a little salt to the compound, or placing a piece of rock-salt or a piece of chalk in the crib occasionally for the animals to lick, would, I think, be found useful as a stimulant and corrective, and benefit the health of the animals. At any rate it might be tried.

The foregoing explanations will, it is hoped, be sufficient for enabling the reader to understand the objects as well as the several details of box-feeding, which may be adopted by any farmer, however limited his means, if he begins in a small way at first, increasing the number of his boxes and other appliances as success enables him to advance. Wherever the landlord affords encouragement, by furnishing materials and assisting in the construction of the requisite buildings, all difficulties will at once be overcome; and there is, I believe, no way in which the landlord could more effectually assist his tenant, than by encouraging and enabling him to adopt a system of box-feeding, coupled with the cultivation of flax for the seed and fibre.

It may perhaps be questioned, whether boxes of the form described are really essential parts of the system, and whether the cattle cannot be fattened with the linseed-compounds in the fold-yard, or in sheds or stalls of the usual form, as well as in boxes;* whether, in short, the boxes, although valuable as

* The results of my experience are, that cattle fatten equally well in stalls and boxes; that in stalls they take up less room, and require less

adjuncts, are still not essentials—the system resting upon the cattle-compounds, by the use of which feeding can be carried on uninterruptedly winter and summer, in the best and cheapest manner.

It may, perhaps, be further said, that in sheds and stalls as usually formed, the cattle being tied up and prevented from moving about, will fatten faster, and may be kept cleaner. That fresh bedding every day, or every second day, will be more wholesome for the animals than where it is permitted to go on accumulating for a length of time, as such accumulations would be liable to emit noxious effluvia in the process of fermentation, which might prove injurious to the animals.

These and similar objections may very possibly be raised, and may have more or less weight with intelligent persons, who have not had an opportunity of witnessing the system of box-feeding herein described.

With respect to the first objection—whether results equally satisfactory might not be obtained by house-feeding in the usual manner, I am not prepared to speak with confidence. Possibly the animals might thrive as well, if similarly fed; but I cannot assert that they would, neither can I say they would not. Experience must settle the point; and where stalls already exist on a farm, the obvious course will be to use them, feeding the animals with the compounds as herein directed. But, in order to test the relative merits of stalls and boxes, a few of the latter should be prepared; and if found to answer better than the stalls, with respect to the cattle and the accumulation of manure, as I believe will be the case, the number of boxes may then be increased at discretion.

With respect to the second and similar objections, I can only say that I saw no ground whatever for entertaining them when I visited Trimingham. On the contrary, the boxes appeared clean, sweet, and wholesome; the cattle were evidently thriving in them, there was no noxious effluvia, every particle of manure was preserved, and the general management appeared to answer perfectly in every respect. And I may further add, that all inquiries which I have since been enabled to make, confirm the impression I then received of the perfect efficiency of the system for the object contemplated.

However the cattle may be fed, whether in stalls or in boxes, the manure is always a matter of primary importance. This really constitutes an essential part of the system; for, unless the manure be properly preserved, the largest amount of produce

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straw to keep them clean and comfortable; but that in boxes the manure is better made and preserved. H. S. Thompson.

cannot be obtained from the land. Now, in the boxes not only is the largest quantity of manure obtained, but the whole of it is preserved, none runs to waste, none is lost; and all that is required to be done, is to scatter a little fresh litter from time to time as the bedding becomes wet or soiled. The cattle move about in the boxes, and tread and tramp the whole down into a solid mass, so close and compact as to prevent fermentation; and when this solid mass of fertilizing material is removed, at the end of every two or three months, as the case may be, if it were immediately applied to the land, perhaps the greatest amount of productive energy of which the land is susceptible would thereby be imparted to it.

But, with house-feeding in the usual way, the management is and must be different. The cattle are tied up in stalls, having no more room allowed than is necessary for enabling them to lie down, and fresh litter is supplied every second or third day, the whole of the old bedding being then removed and carried to the manure-heap; in doing which it is impossible to prevent loss, especially of the finer and more valuable portions. Then, unless the manure-heap be kept covered in some way, it will be washed by rain, and will heat and throw off its more volatile particles, and the fertilizing qualities of the manure will thereby be greatly reduced. Indeed, it is essential in order to preserve it in its most effective state, that all manure should be protected from rain, and from the action of the atmosphere, until the time arrives for its application to the land; and when removed, it ought to be deposited on dry mould, ashes, or other absorbent, to receive the drainings which escape from the heap.

As regards manure, therefore, the mode of management in connexion with box-feeding, appears to be decidedly preferable to that in use for feeding, in stalls, and I believe the boxes will likewise be found preferable in most other respects. They have answered exceedingly well wherever they have been tried; and as example is in general of more weight than precept, I give at the end an instance of the results of box-feeding obtained from Mr. Warnes, and which he permits me thus to use.

A great man of the present day, who seems to possess the faculty, intuitively as it were, of seeing the truth at a glance, however deep in the well it may be immerged, remarked on a late occasion:—"I have long been telling my people that they depend too much upon the barn-floor; they should attend less to the barn-floor, and more to feeding stock." Now this is practically the substance of all that can be said on the subject; and if our farmers will take the advice, and rely less exclusively upon the barn-floor, and look to other objects as well—especially to cattle-feeding, without which the barn-floor will after all be but

slenderly furnished—if they do this, they will speedily find their advantage in the change; and one important means to this end will be found in extending the cultivation of flax, which will give feed for their cattle, abundance of manure, and increased produce from their land: and lastly, but not least in importance, it will give profitable employment for their people.

Result of six months' box-feeding the following stock, by Mr. Warnes, at Trimingham.

			£	s.	d.		£	s.	d.
7 Durham	bullocks,	purchased for	59	10	0	sold for	136	10	0
10 Scotch	ditto	ditto	100	0	0	ditto	215	0	0
1 Cow	ditto	ditto	5	5	0	ditto	15	0	0
			164	15	0		366	10	0
		Deduct cost					164	15	0
		Profit exclusive of keep . . .					201	15	0
The above cattle, together with ten small steers and heifers fed in like manner, consumed 19 acres of turnips, 14 quarters of linseed, a few bushels of barley-meal, and a proportionate quantity of hay and pea-straw chaff; the 10 steers and heifers were not sold with the others, but the increase in their value during the six months is estimated at							84	0	0
Profit on the whole exclusive of keep							285	15	0
Deduct 40*l.* for the 14 quarters of linseed, and 4*l.* for the barley consumed							44	0	0
Leaves a return for feeding as above, for the turnips, hay, and straw, without reckoning the manure thereby obtained, of							241	15	0

XXI.—*Comparison of the Consumption of Food by Large and Small Animals.* By George Shackel.

To Mr. Pusey.

Dear Sir,—I was from home on the arrival of yours dated 30th September, or I should have answered it earlier. The lambs which I mentioned to you as having wintered last year were both of the Hampshire breed, 100 in each lot. I will with pleasure repeat what I stated on Wednesday last respecting the feeding and quantity, and also give you an account of the cost of each lot as well as the proceeds of the sale when they were fat. The two lots were fed at the same time on the same food, and penned on the same ground, but were kept separate from the commence-

ment. I allowed each lot when on turnips (because we did not slice the turnips, only the swedes) the same sized piece per day; and when on swedes, which we began about Christmas, 33 bushels (sliced) per day, and 18 bushels of excellent clover-chaff to each lot; and on the 20th of February, 1847, we gave them 1 lb. of oil-cake a-day on an average until they were sold out.

Bought in the last week in October, 1846.

	£.	s.	d.
100 very large Hampshire Down lambs cost per head . .	2	1	0
100 Hampshire Down lambs, weighing about 1½ stone less than above and very much smaller, cost per head . .	1	15	0
	0	6	0

The latter were in much better condition than the large ones.

Sold out from 28th March to 10th May, 1847.

	£.	s.	d.
100 lambs which cost 41*s*., sold at Smithfield and Southall markets, realized on average, with wool	3	1	3
100 lambs which cost 35*s*., sold at the same markets, realized on average, with wool	2	9	0
In favour of large lambs	0	12	3

I ought to add that the markets were about 2*s*. per head in favour of the large lambs, the trade for mutton being about that difference, or rather more, when the large lambs were sold, which would leave 10*s*. 3*d*. instead of 12*s*. 3*d*. in their favour.

Nothing would be more conclusive and satisfactory than a fair trial, in the same manner, between 100 of Sussex and 100 of Hampshire Downs, both lots of their breed of equal value; that is to say, 100 of best Sussex against 100 of best Hampshire, kept on the same land and fairly tested out of doors, as a farmer would wish to winter them.

Perhaps you will be able to get a fair trial between the large and small breeds, and then publish the result, which would be more satisfactory than mine.

With much respect, I am, dear sir,

Yours truly,

GEO. SHACKEL.

Reading, *Oct*. 4*th*, 1847.

NOTE BY MR. PUSEY.

The above trial seemed to me well to deserve a place in the Society's journal, as throwing light upon the question whether large and small animals of the same race do or do not consume food in proportion to their respective bulk. This question is not merely interesting as a point of physiological science, but also in practical farming. A large body of farmers defend the Hamp-

shire or West Down sheep, notwithstanding their plain appearance, by saying that this plain breed comes to a greater weight, and therefore makes a greater money return, than the Sussex or true South Down. The breeders of South Downs reply that, if their sheep are smaller, more of them can be kept on the same farm. Here then the abstract question has a practical bearing. Last winter I saw a little Devon beast by the side of a large Hereford preparing for the show of the Smithfield Club, and Mr. Trinder's feeder informed me that the small one ate about as much as his more bulky neighbour. In this second instance there was a very decided difference between Mr. Shackel's two lots, yet the larger lambs were satisfied throughout with an equal allowance of each kind of food; and, though of the same breed, made a better return by 4*s.* a-head than the smaller sheep. This plain fact seems to warrant me in calling the attention of practical men to this point of farming.

PH. PUSEY.

XXII.—*The Sheep-Pox; its Causes, Symptoms, Prevention, and Cure: in a Letter to the President and Council of the Royal Agricultural Society of England.* By J. STANLEY CARR, Esq., Honorary Member of the Royal Agricultural Society of England, and several Continental Agricultural Societies.

To the President and Council of the Royal Agricultural Society of England.

MY LORDS AND GENTLEMEN,—Having learned with much regret, not only through the English newspapers, but private channels, that the Sheep-pox, with whose ravages in this country I am well acquainted, had unhappily been conveyed to Britain by some recent importations of sheep from Hamburg, I hastened to contribute my mite towards checking the progress of so great an evil by sending, by last post, a letter to the *Mark Lane Express,* briefly stating the course adopted in these countries when the malady appears in a neighbourhood; and promising to give further directions on the subject, in the shape of a pamphlet. This pledge I had intended to redeem by a treatise of some length, but reflection on the urgency of the case, and the sad probability, that, while scientific men are experimenting, whole flocks will be lost, has induced me to bring the substance of such information as I have to offer, at once before the public; and by throwing it into the form of a letter to you, Gentlemen, secure the attention of the farmers of England, feeling assured that the motive will excuse me in your eyes for thus addressing you through the medium of the Press.

The Sheep-pox is well known in Germany, appearing occasionally in different and widely separate localities, and as its ravages are both great and rapid, its treatment has deservedly occupied an important place in the writings of theorists, as well as in the careful attention of sheep-owners. The result has proved the benefit of such pains-taking observation; for, although the malady was formerly very common in Bohemia, yet at present, when more care is bestowed on the tendance and nourishment of the flocks, it has become much more rare, making only occasional outbreaks in different seasons and districts,—more especially in deep-lying, moory, swampy soils (or such as are subject to be flooded), and where the generation of miasma is facilitated and fostered by a warm climate. In healthy, dry situations, where the sheep-houses are suitably constructed, and the pastures of sound quality, there is little ground for apprehending a spontaneous occurrence of the sheep-pox, which, though highly infectious, is not generally regarded as epidemic. It strongly resembles, indeed, in all its stages, the small-pox, as exhibited in the human subject, and is found to yield to the same remedy. Like the small-pox, too, it occurs in two varieties—the mild and harmless, and the malignant and deadly. The first symptoms of incipient taint are, loss of appetite, swollen eyelids, a somewhat staggering gait, and slight fever. Close examination will easily detect an unusual redness of the skin, and after the lapse of three or four days, small, raised, purple spots may be discovered on the parts where there is least wool—(as inside the thighs, under the shoulders, and on the head)—generally about one-eighth of an inch in diameter, surrounded by a red ring, and flattened in the centre, These fill by degrees with a thin, transparent lymph, which, in process of time, assumes the nature of matter (pus), at which stage of development the animal appears relieved, and, lastly, the pustules dry into a scab and fall off. Such is the progress of the mild variety. When, however, the disease appears in a malignant form—and which, unhappily, is the more frequent occurrence—the pulse becomes increasingly rapid, the mouth dry and hot, the breath fetid, and the eyelids, and even head, so much swollen, that the creature can scarcely be recognised. The pustules, being very numerous, become confluent, and form a mass of matter, which, especially in warm weather, is apt to assume a putrid character, degenerating into malignant ulcers, by which the poor animal is rendered blind, lame, or loses parts of the lips, and is at length carried off by violent diarrhœa.

In such sad circumstances, the certain destruction of the greater part of the flock may be anticipated; and as remedies, whether external or internal, can avail nothing in those advanced

stages of the disease, the only hope of saving those less affected is at once to kill the leprous sheep—thus freeing the others from their pestiferous exhalations—and to bury the carcasses, wool and all, in some far-isolated spot. Previously, however, to things having reached such extremity, the attendance of a skilful and intelligent veterinary surgeon may be successful in warding off the catastrophe from at least a proportion of the flock. But as in no case the proverb, 'Prevention is better than cure,' can be found more pointedly applicable than in relation to the sheep-pox, I strongly recommend all sheep-owners who hear of this frightful scourge having appeared in their neighbourhood, or who, from living near thoroughfares by which imported sheep are accustomed to be driven, have reason to anticipate the possibility of their sound flocks coming into casual contact with strange, perhaps infected, animals, or the ground which such have passed over, to lose no time in adopting the safe, easy, and often-tested antidote against this justly dreaded disease, which INOCULATION affords them.

This is practised in two ways: either regularly from year to year on the lambs, as a preventive of natural sheep-pox, in localities where the disease was formerly of frequent occurrence; or it is resorted to occasionally, when the malady has shown itself in the vicinity, or even in one's own flock (for the premonitory symptoms are always such as must attract the notice of a careful shepherd), and an *immediate* resort to inoculation will not only generally rescue nine-tenths of the still unaffected sheep from all dangerous attacks, but often lighten the disorder to even those individuals of the flock on which symptoms of disease had already manifested themselves. As practice justly weighs more with Englishmen than theory, however plausible, I shall here shortly relate my own experience of the sheep-pox, and the result of inoculation both as a preventive and curative remedy.

About seven years ago I heard of the disease having appeared in this neighbourhood, and resolved at once to try inoculation, of the good effects of which I had both read and heard from credible sources. On close examination of the flock a few sheep were found to be already infected. These were, however, along with all the others, lambs included, inoculated in the ear, in conformity with the published recommendation of the Austrian Government in Bohemia; and the result was in the highest degree satisfactory, as we did not lose above one per cent. of sheep, and six per cent. of lambs. I cannot now recall to mind, whether any of those evidently infected before inoculation died or not; but I know all did not: and particularly remember that several South Down ewes, which I had shortly before imported from England, and about which I naturally felt very solicitous, had the disease

so strongly as to lose part of their ears, yet not one of them died. The inoculation plan was equally successful with many of my tenants, who followed my example and urgent advice; but in another village on this estate, where the peasants, from a dislike to novelties, suffered the contagion to take its course, there was not, to the best of my recollection, a single sheep left alive.

For the sake of distinctness, I shall now proceed to state the mode, the most favourable time for, and the general effects of, inoculation, when it has been effectively operated, as well as some rules to be observed in the treatment of the inoculated animals.

Mode of Inoculation.—Where yearly inoculation is practised, it is customary to reserve a stock of inoculating materials from one year to another, always taking particular care to obtain it from individuals which have the disease in a mild form, and which are apparently otherwise in a sound state of health. In cases of sudden emergency, arising from already existing or dreaded infection, the inoculating virus must of course be procured with all possible dispatch, yet with as careful selection as to mildness of form as circumstances will permit. If the inoculation be only precautionary, a very small quantity of lymph will suffice to inoculate a few sheep, which must be immediately severed from the rest, to prevent the disease being conveyed by contact, and thus introducing a natural sheep-pox, which, like its congener in the human subject, is always more virulent than the artificially produced. From these first inoculated, a supply of good healthy lymph will be obtained for inoculating the remainder of the flock. The places best suited for the operation are the inner side of the flap of the ear, or the under part of the tail, close to the root. The instrument employed is a kind of needle made for the purpose, with a fine, somewhat flattened point, which, having been dipped in the virus, is carefully inserted between the upper and second skin, cautiously avoiding piercing so deeply as to draw blood, which is found to render the success of inoculation less certain. Of course, in the absence of such a needle, a lancet will answer the purpose.

Time for Inoculating.—The most favourable season for yearly inoculation is late in the spring, or early in the autumn, say the latter half of April; or from the beginning of September to the middle of October. In cases of feared infection there is unhappily no room for choice.

Effects of Inoculation.—When the operation has proved effectual, symptoms of fever appear about the fourth or sixth day; the inoculated parts become red, and throw out pustules, which, on the ninth or tenth day, will be found filled with a thin transparent lymph, which is then fit to be used as inoculating virus. As, however, even with the utmost care, many animals do not

take the infection by the first inoculation, it is requisite to examine the whole flock after the lapse of six or seven days from the date of the first operation, and to inoculate a second time wherever the first has proved abortive.

Treatment of the Sheep after Inoculation.—1st. Care must be taken to provide them with airy and roomy stabling, so as to prevent them as much as possible crowding together, which is very apt to induce a malignant state of the disease, even when at first disposed to assume a mild form.

2nd. It is absolutely necessary to keep them carefully guarded against cold, and especially thorough draughts.

3rd. Although, during warm and *dry* weather, both of the above-mentioned evils are avoidable, by placing the sheep during the daytime in a dry, sheltered, and not too distant paddock; still it must be remembered, that exposure to rain, dew, or fog would prove highly dangerous to them. They must therefore be housed at night, and when housed fed, in addition to good hay, with coarse meal, some of which ought also to be mixed with the water they get to drink.

If all the foregoing measures have been adopted, and the disease appear in a mild form, internal medicine may be entirely dispensed with. Should, however, symptoms occur which render it desirable, the following powder may be advantageously administered:—

Take equal parts of saltpetre and sulphur, reckoning one drachm of the mixture to a dose, to which must be added, for the first three days, two or three grains of rock-salt in powder; these ingredients to be intimately incorporated with raw oatmeal, and left beside the sheep for them to lick it; after three days camphor may be substituted for rock-salt.

From the time that *pus* begins to form in the pustules, as well as during their scabbing and drying off, a slight acidulation, by means of vitriolic acid, of the water given to the sheep to drink, has been found useful. This summary, simple and easily practicable as it is, contains the substance of all the theories on the subject of sheep-pox on which experience has stamped the seal of approval. Precautionary measures on this side of the North Sea, for ascertaining the soundness of sheep about to be shipped could scarcely be enforced, since incipient taint may exist, and yet no symptom appear till drawn forth by the warmth of the hold. The sanitory cordon must therefore be drawn in England, if anywhere; and it might perhaps be advisable to appoint competent persons at all sea-ports to which sheep are imported, to examine the animals on landing, and empowered, when suspicious symptoms appear in any one of a flock, to subject the whole to a week's quarantine, during which the existence or non-existence of

the sheep-pox among them must be evidenced. I would also venture to suggest, that it might be worth while to make experiment with the cow-pox on sheep, since it may possibly produce an amelioration of their disease, similar to that which the human race has derived from the introduction of vaccination. With the earnest desire that, meanwhile, the adoption of inoculation may be found as efficacious in England as it has long proved on the Continent, for the suppression of so terrible a scourge,

I have, &c.,

J. Stanley Carr.

Tüschenbeck (*Duchy of Lauenberg*),
October 18*th*, 1847.

XXIII.—*Agricultural Chemistry. Turnip Culture.*

By J. B. Lawes.

Experience is a legitimate and trustworthy guide in all the great practical arts affecting the physical condition of the human race, and, for agriculture as for many other branches of industry, has attained a considerable degree of progress independently of the aid of science; but in so far as experience, as distinguished from principle, is relied upon, must we be content that the soundest practices should only be adopted by that small proportion of the entire masses who exercise an intelligent observation, and have arrived at rules for future guidance more or less by the lessons of past error. But although the results of investigation into the rationale of well recognised practices should prove them to be in the main consistent with philosophy, rather than show them to be fundamentally erroneous, yet, when it is remembered that a well understood and simply explicable principle is much more easily acted upon and by a much greater number of individuals than are the dictates of the most acute empiricism, the claim of science as an improver, as well as an exponent of the economic arts, must be fully admitted. The young man of average talent and education, by the assistance of principle, attains comparatively early the position which otherwise half a life is spent in seeking. Granting, however, what we are by no means called upon to do, that the best practices of the age are beyond the aid of science, and that their more current adoption rather than their improvement is to be expected, a better knowledge than is now prevalent, regarding the first principles of vegetable growth, will serve to protect the farmer from the many snares into which either fraud or ignorance would lead him. If, then, the results of investigation

should tend to explain and to enforce good old practices, rather than to put forth those which are new and untried, the utility or even the necessity of the application of science to the improvement of our national agriculture will not be the less evident.

The question with the agriculturist is not so much what are the constituents which must exist in his soil for the growth of a given amount of produce? but what constituents or class of constituents does this or that crop exhaust, relatively to another constituent or class of constituents? Looking at the subject in this point of view, we are of opinion that the increased growth of corn may be considered to have a very intimate relationship to the amount of nitrogen supplied to the soil: and since, owing to the scarcity and high price of ammoniacal salts, or other direct nitrogenous supplies, it is impossible to rely upon these sources, a rotation of crops, and the importation of food for stock, come to be not merely the only generally applicable, but the most economical means of restoring fertility to the soil. Under such a course for the special accumulation of nitrogen, it will be found that there is always secured an abundant coincident supply of mineral and carbonaceous substances, and hence the direct importation of these latter substances is seldom necessary.

The results of our experiments upon wheat and other plants of the gramineous family have indeed shown, beyond a doubt, that the character of the exhaustion which the soil suffers by their growth is essentially and pre-eminently nitrogenous; and since common usage bears ample testimony to the efficiency of alternate cropping, it is to be supposed that an examination into the composition, habits, and sources of growth of the plants which enter into a rotation, would bring to view important functional differences and peculiarities in the different plants, and such as should give confidence in general principles and tend to improvement and economy in practice.

The greatly varying form and appearance of the various agricultural plants, implying, as undoubtedly they do, essential differences in their sources of nutriment, have led, from but superficial observation of them, to erroneous assumptions regarding the true office of certain plants in a course of agricultural cropping. Thus it is by some maintained that the large surface of leaf put forth to the atmosphere by the turnip, taken in connexion with the general character and utility of the crop, bespeaks an almost exclusive reliance upon the natural resources of the atmosphere for its carbonaceous supply; and the direct application of nitrogenous manures has accordingly been recommended with the view of favouring to the greatest extent the development of leaf as a means of securing bulb.

Again, agricultural plants have been arranged according to

their botanical alliances; and distinctions between the necessary conditions of artificial supply of certain constituents have been made, which are inconsistent with the dictates of experience, and equally so with those to which we are led when other circumstances besides the (nevertheless important) botanical distinctions are brought into consideration. The varying quantitative reliance upon the atmosphere and the soil of different natural families of plants constitutes indeed a most interesting and important point of study, and the principles upon which the *natural system* is founded may derive essential confirmation from chemical researches; but in referring the varying agricultural value of different plants to the functional characters of the several natural orders to which they belong, it must always be first decided that the natural aim and tendency of the plant and order are favoured by our methods and objects of cultivation, and that the agricultural value of the plant is in no way dependent on a monstrous or artificial development at variance with that of its individual health and reproductive tendencies.

The cultivation, habit, and uses of the turnip are well suited to form a contrast to those of our grain crops; and the plant itself may, to some extent, be taken as the type of the green or fallow crops, a main effect of which is the preparation of the soil for the after-growth of corn. The essentially artificial condition which is induced in the cultivation of the turnip plant, for feeding and manuring purposes, is most strikingly illustrated by the effect of climate and manures upon the quantity and composition of the produce.

We shall now proceed to discuss in detail the results of experiments which have been in progress in the field and in the laboratory for several years, and which were undertaken with the view of elucidating some of the general effects of rotation. From the commencement of the inquiry it has been our wish to avoid, as far as possible, the bias of any of the conflicting opinions which have of late years been put forth upon the important subject under examination, and it will be our endeavour, as we proceed in our Report, impartially to lay before our readers such results of direct experiment as will enable them to form their own estimate of the soundness of any views which we may advocate or adopt.

At the outset, however, it may be well to caution the agriculturist against expecting what we by no means presume to exhibit. The object of the experiments has not been the production of immense crops, but to trace, as far as we were able, the real conditions of growth required by the turnip, and to distinguish these from those of the crops to which it is to a great extent subservient. To attain our object it will be necessary to speak of amounts of produce which may at first sight excite the ridicule of those who

do not fully appreciate the nature of the question at issue; but those who choose to go through the details which we are about to quote will, it is thought, find that a true understanding of them tends much to explain the principles upon which the best agriculture is founded.

Before entering upon a consideration of the turnip results themselves, we shall remind the reader of some of the leading facts which may be assumed, regarding the conditions of growth of the wheat plant.

In the paper on "Agricultural Chemistry" in the last number of this Journal, a series of experiments was quoted for the purpose of showing the effect of season and manuring upon the growth of wheat; and a careful consideration of them led to some very important conclusions regarding the nature of the exhaustion by corn-cropping, and also as to the varying nutritive and marketable value of specimens of grain, having different characters and composition, traceable to known conditions of growth.

It was seen that the varying quantity and the quality of the produce of a plot of land, unmanured during several successive seasons, were materially dependent on the number of rainy days, the inches of rain and the temperature, of the months of May, June, July, and August, during which periods the accumulative and elaborative processes of the wheat plant are most actively determined. The average annual produce of the soil and season, unaided by manure, amounted to about three-fourths of the estimated yield of the neighbourhood under ordinary cultivation—to two-thirds of that of a plot manured by farm-yard dung—and to fully half as much as might be expected from as high a course of farming as the soil and the climate with which we have to deal would justify us in adopting. It is remarkable too that, whilst the quality of this natural produce, as indicated by the relation of corn to straw, and the weight per bushel of the corn, varied year by year according to season, yet the characters of the crops grown by very various and, in some cases, rather high manures, were for each season somewhat similar to those of the produce of the unmanured plot. It is evident then, that the conditions favourable to an increased growth of wheat are perfectly consistent in *kind* with the natural tendencies of the plant, and that they only differ *quantitatively* from the natural resources of soil and season, and less indeed in this respect than might have been supposed.

The following table exhibits the influence of season upon the produce of turnip-bulb unaided by the supply of manure. The soil upon which the experiments were conducted was a somewhat heavy loam, not well suited for turnips; the previous crops since manure having been wheat, clover, wheat:—

Season.	No Manure.				
	Bulb per Acre in				Average weight of bulbs in lbs. and tenths.
	Tons.	cwts.	qrs.	lbs.	
1843	4	3	3	2	0·52
1844	2	4	1	0	0·36
1845	0	13	2	24	0·11

It is seen that in three years the produce of this unmanured plot was reduced from $4\frac{1}{4}$ tons to $13\frac{1}{2}$ cwts. per acre; in the fourth season (1846) the bulbs only averaged the size of a radish, and were considered to be not worth weighing. This result strikes us as the more remarkable when we reflect that to the turnip is attributed a power of reliance upon the atmosphere for its organic constituents, to which it is supposed is due its efficacy in restoring fertility to the soil, and increasing the after-growth of corn, which itself attains to a moderate crop under the influence of soil and season alone. The evidence here afforded of the totally artificial conditions which are induced in the cultivation of the turnip for feeding and manuring purposes, is of the clearest kind; and we shall have occasion further on to refer to other points than those here given, as illustrating so curious a result.

Our present object is to show the entire absence of any beneficial influence of season upon the growth of the turnip, independently of artificial supply of constituents. An inspection of the two following tables, giving the results obtained by various manures during three seasons, and the characters of the seasons themselves, affords some insight into the general influence of climate upon the growth of the *cultivated* turnip. It must be admitted, however, that the relation is by no means so quantitatively definite as in the case of wheat; whilst the conditions suited to the favourable growth of the two plants are very opposite in kind:—

Season.	Bulb per Acre, in Tons, cwts., qrs., and lbs.												Average weight of Bulbs in lbs. and tenths.		
	12 Tons Farm-yard dung.				Superphosphate of Lime.				Mixed earthy and alkaline Phosphates and Sulphates.				12 Tons Farm-yard dung.	Super-phosphate of Lime.	Mixed earthy and alkaline Phosphates and Sulphates.
	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.			
1843	9	9	2	9	12	3	2	8	11	17	2	0	1·36	1·47	1·35
1844	10	15	1	0	7	14	3	0	5	13	2	0	1·19	0·81	0·68
1845	17	0	3	6	12	13	3	12	12	12	2	8	1·61	1·17	1·16

A detailed consideration of the produce of the several seasons under different conditions of manuring, as just given, cannot fail to show in which were the climatic influences most favourable to the growth of the cultivated turnip. It will be remembered that, without manure, the produce of the first of the three seasons was much below the most meagre agricultural amount; and that in the third and fourth it dwindled to almost nothing. This table, on the other hand, shows that under a course of manuring the third season yielded the largest crop, and the second invariably the least. The average produce of the first season, where farm-yard-dung is employed, is not superior to that of the second season under similar conditions of supply, though it is so in each of the cases where mineral manures alone are used. If we look to the average weight of the bulbs, however, as given in the table, it will be seen that the development was superior in the first year to that in the second, though inferior to that in the third. The seeming depreciation in the first season, indicated by the average yield, arose from the adventitious circumstance of the greater destruction of plants by disease in that season, from which cause their number was greatly diminished. The discrepancy is therefore apparent rather than real; the result being dependent, not upon the *amount* of supply by season and manure, but upon injury which is more frequently connected with rich than with poor manuring. Again, neither the acreage produce nor the average weight of bulbs, where mineral manures alone were employed, shows so marked a superiority of the third season as compared with the first, as is evinced in the case of the farmyard-dung, by which a large amount of *organic matter*, was supplied to the plants. We shall have occasion to show however, when treating of the effects of *manures* upon the growth of the turnip, that there was a deficiency of *carbonaceous supply in the soil* in the cases where mineral manures alone had been used, which gave to the farmyard-dung its superiority in the third season. Upon the whole it is evident from the results, that of the three seasons the third was by far the best suited to the growth of the turnip for feeding purposes, and that the second was the least so. Of the real character of these seasons some judgment may be formed by an inspection of the following table, in which is given a summary of the statistics provided by the rain-gauge and the register thermometer, in reference to the climate of the three seasons during the months of July, August, September, and October, which may be considered to include the period of the active growth of the turnip:—

During July (last 14 days).				During August.			
Season.	Mean Temperature.	No. of rainy days.	Inches of Rain.	Season.	Mean Temperature.	No. of rainy days.	Inches of Rain.
1843	59·7	11	1·04	1843	63·4	12	3·38
1844	65·8	3	0·55	1844	59·7	14	1·84
1845	59·4	7	0·97	1845	59·0	17	2·79

During September.				During October.			
Season.	Mean Temperature.	No. of rainy days.	Inches of Rain.	Season.	Mean Temperature.	No. of rainy days.	Inches of Rain.
1843	61·9	5	0·98	1843	49·0	15	2·62
1844	58·9	14	1·38	1844	50·2	17	4·13
1845	54·8	14	1·77	1845	50·0	10	1·39

By such a summary as is here given, of course only the general differences in the seasons are brought to light; but our readers will probably admit that the greatly increased labour of examination, were the table more extended and in detail, would scarcely be compensated for, if the main characters, requisites, and offices of the *turnip season* can be ascertained without it.

A relatively large number of rainy days, an enhanced actual amount of rain, and a low degree of temperature, are prominently the characters which distinguish the assumed turnip season of 1845 from that of the two preceding years, and during a considerable portion of the period, especially, from that of 1843.

Thus taking the items somewhat in the order in which they are given, we find that in the latter half of the month of July, upon the character of which so materially depended the early development of the plant, and on this its future growth, in the seasons of 1843 and 1845 the temperature was lower than in 1844; and in 1845 the number of rainy days is more than double that in 1844, though somewhat less than in 1843, whilst the total amount of rain was much greater in 1845 than in 1844, and nearly equal to that in 1843. In August we have in 1845 the lowest temperature, the greatest number of rainy days, and, though not the largest actual amount of rain, a quantity large compared with 1844, though below that in 1843. September indicates still the lowest temperature in 1845, a number of rainy days equal to 1844 and far exceeding 1843, and also the largest actual amount of rain. The month of October, on the other

hand, shows in 1845 the *smallest* number of rainy days, as well as actual fall of rain, and a mean temperature not so low as in 1843.

In these facts, even though so general and limited in their indications, there is scarcely one which does not show that the most favourable conditions of growth for our cultivated, bulb-forming turnips are, relatively to those for the seed-producing gramineous plants, a low degree of temperature, a large number of rainy days, and a large actual amount of rain. The seeming deviation from this general postulate, which is indicated by the character of the month of October in the third or best turnip season, is, however, by no means inconsistent with our estimate of the requisites of such a season, but rather conduces still further to account for the observed superiority of effect; for whilst, compared with plants which are cultivated for highly elaborated products, such as the cereal grains, we should expect the mainly accumulative and deficiently elaborative processes of the bulb and leaf forming turnip would require a lower degree of temperature and a greater amount of moisture favouring the circulatory determinations of the plants, there is, nevertheless, a point at which depreciation in temperature is injurious to vegetation. Indeed the full growth of the turnip crop depends greatly on the postponement of the winter temperature, and hence probably arose a real advantage from the relatively high (though actually low) temperature in the October of 1845. Again, the lower the temperature, the less important is a continuity and large amount of rain.

As a general fact, it is evident that the amount of the produce of the turnip is very materially dependent upon the climatic character of the season, not only as in itself a *resource,* but as an *essential agent* in the appropriative power of the plant, however liberal and complete may be the supply of constituents within the soil. Whilst, however, it may frequently happen that the physical characters of the season may be such as not to render available to the plant, and at once profitable to the farmer, the constituents which he has provided by manure, it is evident from the results which have been given, that, *without* an ample manuring, the best adapted season is incapable of yielding an agricultural amount of turnips. It is to be feared, however, that it is more frequently the essential condition of artificial aid, rather than that of natural climatic agency and resource, that is in defect.

Common usage seems to attribute to the turnip and green crops generally a power of collection from the atmosphere which is not recognised in our grain-yielding plants; and it may at first sight appear inconsistent with this view, that the growth of the

turnip in agricultural quantity should be so essentially dependent on artificial supply as our results would show to be the case. There can be no doubt that there is some truth in this current supposition, but there is little doubt that the power of collection from the atmosphere very materially depends upon the quantity and quality of the supply to the soil by manures; in fact, that upon the judicious and liberal provision of certain constituents by art we must rest our hopes for atmospheric accumulation.

Having shown, then, that climatic agencies constitute an important element in the necessary conditions of growth of our cultivated turnip, and that these are only available when associated with an abundant artificial supply of certain constituents, the question arises—What are the substances which it is essential should thus be provided? This brings us to the second branch of our subject, namely, the influence of *manuring* upon the growth of the turnip.

Having discussed in some detail the comparative characters of the first three seasons during which we have been conducting an extensive series of experiments, under very various yet known conditions of manuring, we are prepared to consider the results of those experiments; and it is believed that those of them which were obtained in the three years referred to will amply suffice to indicate the nature of the necessary supply by manure, and also to lead to some interesting and important explanations regarding the true office of the turnip in a course of agricultural cropping, and the sources of its economic value. We would again remind our readers that the object of the experiments was not the production of large crops, but to learn, by the effects of different and known conditions of supply, in what respect and to what extent the plant was dependent upon the resources which must be kept up by the farmer, and how far he may rely upon the natural yield of the atmosphere; for it is the item of *source* of constituents, as well as that of quantity and quality, which should influence our selection of plants and manures under a truly rational and economic system of agriculture.

The experiments were commenced in the season of 1843, the early part of which, it will be remembered, was greatly superior to that of 1844, and equal to that of 1845 in suitableness to the growth of the turnip; but in the middle and latter periods it was inferior to either of the two succeeding seasons. The soil was a somewhat heavy loam, not well adapted for turnips; but as the plant is cultivated on such land with admitted advantage for rotation purposes, it was well fitted to answer our special ends. The previous crops since manure had been wheat, clover, wheat; so that in an agricultural point of view the soil might be considered as somewhat exhausted, and therefore in a favourable condition

for an inquiry into the influence of supply by manuring. The description of seed was Norfolk Whites. The manures and seed were drilled together on ridges, there being 25 inches between the rows. The plots allotted to each experiment comprised six rows, and consisted of about one-third of an acre. The crop was calculated, from weighed quantities taken from measured portions of land, of about one-eighth of an acre for each lot, and extending across the series in three different places.

TABLE showing the results of EXPERIMENTS upon the GROWTH of TURNIPS by MANURES, at ROTHAMPSTED FARM, HERTS.

First Season, 1843.

Plot Numbers.	DESCRIPTION OF MANURES. Quantities expressed in weight per acre. Each lot made up at the rate of 14 bushels per acre, with clay and weed-ashes.	Average weight of Bulbs in lbs. and tenths.	Number of plants per acre.	Bulb per acre, compared with No. 2 as 1000.	Bulb per acre, in tons, cwts., qrs., and lbs.				Bulb per acre, if 4 plants in a square yard = 19,360 in an acre.			
					Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.
1	12 tons farm-yard dung	1·36	15,571	2262	9	9	2	9	11	15	0	9
2	No manure	0·52	17,940	1000	4	3	3	2	4	9	2	6
3	6¼ cwts. rape cake	1·08	17,043	1967	8	4	3	12	9	6	2	21
4	5½ cwts rape cake, 2 bushels yeast	1·16	15,467	1926	8	1	1	11	10	0	2	1
5	8 bushels yeast	1·21	20,240	2622	10	19	2	19	10	9	0	17
6	2½ cwts. superphosphate of lime, 12 lbs. sulphate of ammonia, 4 bushels of yeast	1·33	19,573	2796	11	14	0	22	11	9	3	17
7	56 lbs. sulphate of ammonia	1·03	14,996	1653	6	18	1	25	8	18	0	5
8	2½ cwts. superphosphate of lime, 3¾ cwts. rape cake	1·69	16,096	2894	12	2	1	21	14	12	0	14
9	1¼ cwts. superphosphate of lime, 5¼ cwts. rape cake	1·52	15,295	2490	10	8	2	5	13	2	2	17
10	3¾ cwts. superphosphate of lime, 1 cwt. rape cake	1·58	18,019	3042	12	14	3	6	13	13	0	13
11	Refuse matter containing much precipitated phosphate of lime, rape cake, &c.	1·42	17,928	2734	11	9	0	5	12	5	1	23
12	2½ cwts. superphosphate of lime, 2 cwts. rape cake, 20 lbs. sulphate of ammonia	1·48	17,112	2720	11	7	3	7	12	15	3	9
13	1¼ cwts. superphosphate of lime, 1 cwt. rape cake, 40 lbs. sulphate of ammonia	1·42	16,617	2531	10	12	0	5	12	5	1	23
14	1¼ cwts. superphosphate of lime, 3¾ cwts. rape cake, 10 lbs. sulphate of ammonia	1·23	17,790	2340	9	15	3	25	10	12	2	12
15	3¾ cwts. superphosphate of lime, 2½ cwts. rape cake, 20 lbs. sulphate of ammonia	1·75	15,088	2841	11	17	3	18	15	2	2	0
16	3¾ cwts. superphosphate of lime, 1½ cwts. phosphate of magnesia-manure	1·39	19,975	2974	12	9	0	15	12	0	1	2
17	3¼ cwts. superphosphate of lime, 150 lbs. phosphate of potass-manure	1·36	19,228	2804	11	14	3	19	11	15	0	9
18	3¼ cwts. superphosphate of lime, 84 lbs. phosphate of magnesia, 75 lbs. phosphate of potass	1·35	19,642	2835	11	17	2	0	11	13	1	12
19	As 18, with 30 lbs. sulphate of ammonia.	1·49	19,113	3045	12	5	0	13	12	17	2	6
20	3¼ cwts. superphosphate of lime, 1¼ cwts. rape cake, 16 lbs. sulphate of ammonia	1·58	16,916	2860	11	19	1	23	13	13	0	13
21	Unburnt bones decomposed by sulphuric acid, 7 bushels	1·48	17,675	2804	11	14	3	19	12	15	3	9
22	4¼ cwts. superphosphate of lime	1·47	18,446	2908	12	3	2	8	12	14	0	10
23	Clay and weed-ashes only, 15 bushels	1·32	18,745	2650	11	1	3	21	11	8	0	20

The terms superphosphate of lime, phosphate of potass, phosphate of soda, and phosphate of magnesia, as found in this table, and others which follow it, are not to be understood as representing the pure chemical substances bearing those names. The composts were formed by acting upon calcined bone-dust by means of sulphuric acid in the first instance; and in the case of the alkaline salts, and the magnesian one, neutralising the compound thus obtained, by means of cheap preparations of the respective bases.

Were we to look at the results of this Table with a purely agricultural eye, the column of acreage weight of bulb would be sufficient to guide our judgment as to the efficiency of the various manures; but since the object of the experiments is rather to provide a key to the requirements of the turnip than to afford exact examples of manuring, other items than that of the actual acreage results obtained must be taken into consideration in forming an estimate respecting the nature of the conditions which cultivation should be calculated to supply. Manures, indeed, cannot be regarded only as containing certain constituents convertible into the substance of the crops, but also as agents acting beneficially or otherwise according to the form or combinations in which they are supplied, and their adaptation to soil and season. Thus it is known that the casualties and tendencies to disease or prevalence of insects often prove more destructive to the young turnip-plant under high farming, when the soil abounds in animal and vegetable matter, than when it is deficient in such substances; and the number of plants per acre may by such causes be so greatly reduced as to show a better acreage yield under bad than under liberal cultivation. The number of plants per acre must not therefore be overlooked in considering the results of the Table. The average weight of bulb may also be taken as to some extent indicating the relative effects of different conditions of growth. Where we have an increased average weight, as well as a large number of plants, both *agency* and *supply* have been favourable to the requirements of the plant; and although the efficiency of either of them is dependent on that of the other, it may as a general fact be assumed that a high number of plants indicates a favourable *condition*, and a large average weight a favourable *amount* of supply. Bearing in mind these considerations, we have given in the last column of the Table the estimated acreage yield, calculated from the actual average weight of bulb, and supposing a uniform number of plants per acre, namely, 19,360, or 4 in a square yard. Such an arrangement would give about 12½ inches from plant to plant along the rows, and may be taken as affording a more just view of the effects of the manures, independently of the contingencies arising from the manner of their application.

In reference to the results of this first season it must further be remarked, that the previous course having been wheat, clover, wheat, the *peculiar* exhaustion of the soil would be that induced by *corn-cropping*; and if there be any truth in the opinions which we have given elsewhere on this subject, this would imply a deficiency of nitrogen relatively to other constituents, so far as the future growth of wheat would be concerned; and it would appear from the amounts of produce without manure during the three seasons, as already given, that in some important respects the con-

ditions of exhaustion most favourable to an investigation into the effects of *supply* for the growth of the turnip, were not so prominent in the first season as afterwards, when the unaided yield was little more than a weed, so that the entire produce under manures could then be attributed either to their *agency* or their *supply*.

The following selected results, showing the average weight of bulbs and number of plants per acre, yielded by manures which, compared with each other, are respectively mineral, nitrogenous, or carbonaceous, will point to some of the conditions which it is essential to provide for the healthy and rapid growth of the turnip:—

SELECTED RESULTS.

Plot Nos.	Description of Manures.	Number of Plants per Acre.	Average Weight of Bulbs in lbs. and tenths.
2	No manure	17,940	0·52
3	6 ½ cwts. rape cake	17,043	1·08
7	5 6 lbs. sulphate of ammonia	14,996	1·03
16	3¼ cwts. superphosph. lime, 1½ cwt. phos. of magn. manure	19,975	1·39
17	,, ,, ,, 150 lbs. phos. potass. manure	19,228	1·36
18	,, ,, ,, 84 lbs. phos. mag. 75 lbs. phos. pot. manure	19,642	1·35
22	4½ cwts. ,, ,, ...	18,446	1·47

The figures in the first column show a great destruction of plants under direct ammoniacal supply, as well as considerable depreciation where rape-cake was used; and common experience teaches us that, however useful rape-cake and ammoniacal salts, or guanos containing much ammonia, may be as manures for turnips, substances of their description are never safely applied near to the seed. Other instances than those quoted above from the table at page 503 distinctly show the injurious influence of organic manures when drilled with the seed; indeed, it may be laid down as a general rule that, especially for all spring crops, it is much more safe to apply such matters broadcast, and incorporate them well with the soil. The conflicting accounts which are given of the effects of guano and ammoniacal salts when they are supplied to spring corn crops, and of these manures and rapecake when used for turnips, are, it is believed, mainly attributable to differences in the manner of their application; and whilst with a very wet season no injury, or perhaps benefit, may arise from the use of the manure drill in such cases, by far the safest course is to sow broadcast.

The second column of the selected results shows for this season of 1843 a considerable superiority in point of *development*, as well as *number*, of surviving plants, under purely mineral by the side of organic manures; and, compared with the unmanured plot,

those having manures only mineral indicate a growth almost threefold in the same space of time, whilst the actual acreage amount of produce is in these cases very nearly as great as in any of the series; indeed, mineral manures alone have nearly trebled the unaided produce of the soil and season.

These results might almost lead us to question the importance of organic manuring for the turnip crop, and to assume that a deficiency in mineral matters was the source of impoverishment in the case of the soil selected for experiment; but as we proceed it will be seen that, however marked may have been the effect of mineral matters in developing the powers of growth of the plant, as long as a sufficiency of organic food remained, yet a point of exhaustion was arrived at when, by a less amount of mineral matter, if in conjunction with organic supply (especially such as could yield *carbon* to the plants), the rapidity of *bulb* formation was materially enhanced.

Before leaving these results it is as well to observe, that notwithstanding the large amount of potass required by the turnip, the direct supply of that alkali did not give a produce superior to that by superphosphate of lime. We shall have occasion to recur to the question, whether part of the effect of the latter manure is not due to its liberation in the soil of alkalis not otherwise available to the plant. All we wish to call attention to at the present is, that there was an abundant amount of alkalis in this corn-exhausted soil, which could be rendered serviceable under suitable management.

The next quotations which we shall make from the table (page 503) will serve to illustrate the effect of the artificial supply of matter for organic formations, aided by certain mineral agency and constituency :—

SELECTED RESULTS.

Plot No.	Description of Manures.	Average weight of Bulbs.	Number of Plants per Acre.
8	$2\frac{1}{2}$ cwts. superphosphate of lime, $3\frac{3}{4}$ cwts. rape-cake . .	1·69	16,096
9	$1\frac{1}{4}$,, ,, $5\frac{1}{2}$,, ,, . .	1·52	15,295
10	$3\frac{3}{4}$,, ,, 1 ,, ,, . .	1·58	18,009
12	$2\frac{1}{2}$ cwts. superphosphate of lime, 2 cwts. rape-cake, 20 lbs. sulphate of ammonia	1·48	17,112
13	$1\frac{1}{4}$ cwt. superphosphate of lime, 1 cwt. rape-cake, 40 lbs. sulphate of ammonia	1·42	16,617
14	$1\frac{1}{4}$ cwt. superphosphate of lime, $3\frac{3}{4}$ cwts. rape-cake, 10 lbs. sulphate of ammonia	1·23	17,790
15	$3\frac{3}{4}$ cwts. superphosphate of lime, $2\frac{3}{4}$ cwts. rape-cake, 20 lbs. sulphate of ammonia	1·75	15,088
19	$3\frac{1}{4}$ cwts. superphosphate of lime, 84 lbs. phosphate, magnesia, 75 lbs. phosphate of potass, 30 lbs. sulphate of ammonia .	1·49	19,113
20	$3\frac{1}{4}$ cwts. superphosphate of lime, $1\frac{1}{2}$ cwt. rape-cake, 16 lbs. sulphate of ammonia	1·58	16,916

It may be objected that the average weight of bulbs as stated above is in itself small, and that the differences exhibited are too slight to be relied upon as showing a result. We would beg to say, however, that the estimations were taken from the whole of the bulbs that were weighed in each case, amounting to nearly 2000, and that we believe they may be depended upon for our present purpose.

It will be remembered that with mineral manures alone there were, on an average, rather more than 19,000 plants per acre, but a glance at the results just given will show how uniformly the direct supply by the drill of "organic manures" tended to lessen the number. Again, it has been seen that the highest average weight of bulbs (indicating the degree of development) was, by purely mineral manures, 1·47 lbs., by sulphate of ammonia 1·03, and by rape-cake alone 1·08 lb. The fact that these conditions of manuring, employed singly, fall far short of their effects when combined, helps us to form some judgment as to the point at which the one or another class of constituents seems to fail, either in quantity or in adaptation to the wants of the plant.

Taking the lots 8, 9, and 10, we find the *largest* number of plants where the proportion of mineral supply to that of rape-cake is the greatest, and the *smallest* number where the rape-cake is relatively in excess. The weight of bulbs is *least* where the mineral matters are most in defect, and *greatest* where neither condition was to the other so prominent as in the other two cases.

Again, taking Nos. 12, 13, 14, and 15, in which superphosphate of lime was united with both rape-cake and ammoniacal salt, the largest weight of bulb in the entire series of the season is found to be in that case where, with a fair supply of each, no one of the several manures predominated so much as in either of the three other instances just mentioned,

Were we to place unconditional reliance upon mere supply of constituents for *actual conversion into the substance of the plant,* we should expect that the farm-yard dung would give, in every respect, the best crop in the series; but *agency,* as distinguished from mere *supply,* seems to constitute a most important item, affecting the development of those truly artificial conditions of growth which the cultivation of the turnip, for feeding and manuring purposes, so pre-eminently implies. In the farm-yard dung we had undoubtedly the largest provision of nitrogenous, and especially of carbonaceous matter, and it may be supposed that it also brought to the soil such an abundance of all the mineral substances as would be contained in a much larger crop than was produced by it.

The results arranged below will sufficiently prove that, however liberal the supply of all required constituents, the health

and vigour of the plant, or its power of appropriating the food presented to it, depends upon other circumstances than the mere *amount* of that food.

SELECTED RESULTS.

Plot Nos.	Description of Manures.	Average Weight of Bulb.	Number of Plants per Acre.
1	12 tons farmyard-dung	1·36	15,571
8	2½ cwts. superphosphate of lime, 3¾ cwts. rape-cake	1·69	16,096
15	3¾ cwts. superphosphate of lime, 2¾ cwts. rape-cake 20 lbs. sulphate of ammonia	1·75	15,088
18	3¼ cwts. superphosphate of lime, 84 lbs. phosphate of magnesia, 75 lbs. phosphate of potass . . .	1·35	19,642
22	4½ cwts. superphosphate of lime	1·47	18,446

We see that the farm-yard dung gave a number of surviving plants nearly as small as any in this series, and very far short of that obtained by mere mineral, or frequently by mixed mineral and organic supply. Again, the weight of bulbs is only equal to the lowest resulting from pure mineral manuring, and inferior to that in other cases of such manuring. In Nos. 8 and 15, on the one hand, the *amount* of supply, especially of matter for organic formations, was much less than in No. 1, whilst the average weight of bulb was materially greater. On the other hand, the mineral supply was in these cases less than in 22; but there being in that instance no provision by manure of organic matter, the increased mineral supply was unavailing.

Clay and weed-ashes alone, as in No. 23, are seen to more than double the unaided produce of the soil and season, to give a fair number of plants, and an average weight of bulb nearly three-fourths as great as in any case in the series. This is a curious result, and indicates that certain mechanical as well as chemical conditions of soil, in immediate proximity to the young plant, are essential to a favourable and healthy development of its organs of collection. We learn, too, that in some important respects the resource of food within the soil itself could not have been so low in this first year as it appears afterwards to have been.

There are other points indicated by the results already given, than those to which we have directed attention; but as a consideration of the experiments of the succeeding years will bring them before our readers, we need not enter upon them in this place.

Having examined in detail the results of the first year's experiments, it may be well to reiterate some of the more general and important facts and conclusions which have been elicited. It is clearly shown that, under the influence of the same season, and in a soil which, by corn-cropping, had been brought to that condition of exhaustion which common usage would remedy by the

growth of turnips or other green crops by means of manure, the attempt to grow such *restorative* crop without *supplied* aid,—that is, manure,—is quite unavailing. We see that *agency* as well as *supply* is an essential element to be considered in the choice of manures, and that unless such agency or condition of healthy function be secured, a liberal provision of the *materials* of which the plant is built up may frequently, to a great extent, be useless to it. The matters which are most favourable to the healthy action and rapid accumulation and assimilation by the turnip, are the so called "*mineral manures,*" under the influence of which a great regularity of plant and vigorous power of growth are attained. At any rate, in the soil in question, when in a condition of *agricultural exhaustion,* the supply of *potass* by direct manures seems unessential. But the direct supply of phosphoric acid, whether by its reaction upon the soil or a special effect upon the young plant, or from a combination of these influences, seems to enhance the assimilating actions of the turnip to a degree much beyond what could be attributed to it as a *mere constituent,* rather than in some sort an *agent* also. We shall recur further on to this interesting subject.

Of the substances which we may term pure *constituents,* "*organic matters,*" and especially such as abound in *carbon,* must be supplied for the production of agricultural crops of turnip-bulbs. These manures, as well as those which are chiefly nitrogenous, should never be concentrated near to the plant in its earliest stages of growth, but only within its reach, when, under the immediate influence of mineral manures, the young plant has so far developed its organs of accumulation, and its healthy vigour, as to be competent to grow faster than the natural atmospheric and soil resources of nitrogen and carbon enable it to do. These are, we conceive, the most prominent indications afforded by the results of this our first season of experimenting upon the cultivation of the turnip. As we proceed in our inquiry we shall see how far they are confirmed by those which succeeded them, and which we shall now endeavour to detail.

The whole produce, leaf and bulb, of 1843, was carted off the land. In the second year the manures had some reference to the condition of soil as effected by the first year's treatment, and the same division of the land, and the numbering of the plots, was adopted. The manures were again drilled with the seed, and the mechanical culture of the land before and after sowing, the estimation of the crop, and its entire removal, were conducted as before.

The entire series of results of this second season (1844) are given in the following Table at one view, but we shall make selections as before, for the convenience of detailed examination.

TABLE showing the results of Experiments on the Growth of Turnips by Manures, at Rothamsted Farm, Herts.

Second Season, 1844.

Plot Numbers.	DESCRIPTION OF MANURES. Quantities expressed in weight per acre. Each lot made up at the rate of 14 bushels per acre, with clay and weed-ashes.	Average weight of Bulbs in lbs. and tenths.	Number of plants per acre.	Bulb per acre, compared with No. 2 as 1000.	Bulb per acre, in tons, cwts., qrs., and lbs.				Bulb per acre, if 4 plants in a square yard = 19,360 in an acre.			
					Tons	cwts	qrs.	lbs.				
1	12 tons farm-yard dung	1·19	20,096	4875	10	15	1	0	10	15	2	22
2	Unmanured	0·36	13,736	1000	2	4	1	0	3	2	0	25
3	7 cwts. rape-cake	0·27	5,488	294	0	13	0	0	2	6	2	9
4	4 cwts. superphosphate of lime, ½ cwt. phosphate of ammonia	0·92	16,768	3138	6	18	2	0	7	19	0	3
5	4 cwts. superphosphate of lime, ½ cwt. sulphate of ammonia	0·87	14,256	2498	5	10	1	0	7	10	1	15
6	3 cwts. superphosphate of lime, 15 lbs. phosphate of ammonia	0·65	21,632	2867	6	6	2	0	5	12	1	12
7	3 cwts. ground apatite	0·38	17,864	1382	3	1	0	0	3	5	2	20
8	3 cwts. of apatite, decomposed by sulphuric acid, containing 200 lbs. apatite	0·71	21,232	3076	6	15	3	0	6	2	2	25
9	As No. 8, with 56 lbs. hydrochloric acid added (sp. gr. 1125)	0·80	20,392	3320	7	6	2	0	6	18	1	4
10	4 cwts. superphosphate of lime, 4 cwts. rape-cake	1·18	13,256	3173	7	0	0	0	10	3	3	24
11	4 cwts. superphosphate of lime, 4 cwts. rape-cake, 15 lbs. phosphate of ammonia	1·29	10,320	2697	5	19	0	0	11	2	3	26
12	5 cwts. superphosphate of lime, land dug 6 inches deep	0·97	20,152	3968	6	15	1	0	8	7	2	19
13	4 cwts. superphosphate of lime, 4 cwts. rape-cake, 2 cwts. common salt	0·30	7,952	482	1	1	1	0	2	11	3	12
14	5 cwts. superphosphate of lime, land trenched with the spade 18 in. deep	0·99	13,360	2683	5	18	1	0	8	11	0	14
15	1 cwt. superphosphate of lime, 4 cwts. phosphate of soda	0·76	19,504	3013	6	13	0	0	6	11	1	13
16	1 cwt. superphosphate of lime, 4 cwts. phosphate of magnesia	0·70	21,336	3024	6	13	2	0	6	1	0	0
17	1 cwt. superphosphate of lime, 4 cwts. phosphate of potass	0·66	20,552	2775	6	2	2	0	5	14	0	9
18	2 cwts. superphosphate of lime, 1 cwt. each of phosphate of potass, soda, and magnesia	0·68	18,624	2572	5	13	2	0	5	17	2	4
19	Same as No. 18, with 15 lbs. phosphate of ammonia	0·73	20,352	3107	6	13	1	0	6	6	0	20
20	2 cwts. superphosphate of lime, 4 cwts. rape-cake, 56 lbs. sulphate of ammonia	0·78	6,832	1084	2	7	3	0	6	14	3	8
21	374 lbs. apatite, decomposed by sulphuric acid, containing 104 lbs. sulphuric acid, 270 lbs. apatite	0·85	18,728	3247	7	3	1	0	7	6	3	20
22	5 cwts. superphosphate of lime	0·81	21,205	3503	7	14	3	0	7	0	0	1
23	2 cwts. superphosphate of lime, 56 lbs. sulphate of ammonia, 1½ cwts. nitrate of soda	0·83	10,072	1700	3	15	0	0	7	1	2	20

On reference to the summary as already given of the climatic conditions of the turnip seasons of 1843 and 1844, it will be seen, that in the latter half of the month of July, the low degree of temperature, the number of rainy days, and the actual amount of rain, are all most favourable to the early stages of the plant in 1843. Throughout the months of August, September, and October, on the other hand, the conditions of turnip growth, so far as season is concerned, are more favourable in 1844 than in 1843.

A glance at the mean results of the two years will, however, clearly show that if the climatic influences of the second year were in the main superior to those of the first, some other circumstances must be looked for, as accounting for the great falling off in the development of the plant.

SELECTED AND MEAN RESULTS.

Description of Manures.	Average Weight of Bulbs.		Number of Plants per Acre.	
	1843.	1844.	1843.	1844.
No manure	0·52	0·36	17,940	13,736
Mean of mineral supply only	1·39	0·73	19,323	20,377
Rape-cake only	1·08	0·27	17,043	5,488
Mean of mixed mineral and organic supply	1·50	0·97	17,230	14,774

It is here seen, that with a more favourable season, excepting during the first few weeks in 1844, than in 1843, we have nevertheless an inferiority of development under every variety of manuring, and a very marked depreciation in the number of plants, unless where mineral manures alone were used. The destructive effects of organic manures, especially in the absence of rain during the early stages of growth, is here very evident; and the maintenance of healthy action, even under these same climatic circumstances, when purely mineral manures are employed, is clearly shown. We observe, too, that whilst under the influence of this defect of rain during the first period of the season, both the weight of bulbs and number of plants is much less where rape-cake is used alone than even where no manure at all is provided; yet the admixture of mineral manures with the organic, gives the best result in the series so far as development is concerned.

That the cause of the depreciation in average weight of bulbs during this season was, nevertheless, connected with a deficiency of matter for organic formations, and not of mineral supply, the following extracted results will show.

SELECTED RESULTS.

Plot No.	Description of Manures.	Average weight of bulb in lbs. and tenths.
15	1 cwt. superphosphate lime, 4 cwts. phosphate soda, manure .	0·76
16	1 ,, ,, 4 ,, phosphate magnesia, manure	0·70
17	1 ,, ,, 4 ,, phosphate potass, manure .	0·66
18	2 ,, ,, 1 ,, each phosphate potass, soda, and magnesia, manure	0·68
19	As 18, with 15 lbs. phosphate ammonia	0·73
22	5 cwts. superphosphate lime	0·81
5	4 ,, ,, ½ cwt. sulphate ammonia . . .	0·87
10	4 ,, ,, 4 ,, rape-cake	1·18
11	4 ,, ,, 4 ,, ,, 15 lbs. phos. amm.	1·29

Thus, of the purely mineral manures, the superphosphate of lime (No. 22), as in the first year, gives a higher weight of bulb than any of those where alkalies are also supplied. The substitution of 1 cwt. of superphosphate of lime, by half a cwt. of sulphate of ammonia (*see* Nos. 22 and 5), raises the weight of bulb from 0·81 to 0·87; by 4 cwt. of rape-cake (No. 10) to 1·18; and by 4 cwt. of rape-cake, with 15 lbs. of phosphate of ammonia, to 1·29, the highest weight obtained during this season—that by dung not excepted.

The farm-yard dung, as in the previous year, must be supposed to have afforded the most liberal supply of all the matters necessary for conversion into the substance of the plant; yet we find that 4 cwt. of superphosphate of lime, with 4 cwt. of rape-cake, and 15 lbs. of phosphate of ammonia (No. 11), give a higher average weight of bulb than the farm-yard dung; that by the former being 1·29, and by the latter 1·19. We have, however, 20,096 plants per acre by farm-yard dung, and only 10,320 by the artificial organic compost. This deficiency of plants is, however, easily accounted for, by the fact that the dung was ridged in, and the artificial compost *drilled with the seed;* so that the defect of rain during the early stages of the plant, whilst it might only retard growth in the one case, would lead to positive destruction in the other.

The very great destruction of plants, as well as the small weight of bulb, in the case of No. 3, where rape-cake alone was drilled with the seed, further show the impropriety of applying organic manures near to the seed or young plant, and the inefficiency of mere supply of constituents if the healthy development of the collective apparatus of the plant be not secured.

The effects of ammoniacal salts, as they have been before described, depending upon a proper combination with other constituents, are further exhibited in the results of this second year. The variations in the number of plants and weight of bulbs, in Nos. 4, 5, and 6, and also in the results of these numbers as compared with those of Nos. 11 and 20 here given, may be adduced in illustration of this fact.

SELECTED RESULTS.

Plot Nos.	Description of Manures.	Average Weight of Bulbs in lbs.	Number of Plants per Acre.
4	4 cwts. superphosphate lime, $\frac{1}{2}$ cwt. phosphate ammonia .	0·92	16,768
5	4 ,, ,, ,, $\frac{1}{2}$ cwt. sulphate ,, .	0·87	14,256
6	3 ,, ,, ,, 15 lbs. phosphate ,, .	0·65	21,632
11	4 cwts. superphosphate lime, 15 lbs. phosphate ammonia, 4 cwt. rape-cake	1·29	10,320
20	2 cwt. superphosphate lime, $\frac{1}{2}$ cwt. sulphate ammonia, 4 cwt. rape-cake	0·78	6,832

Thus there is a slight superiority in No. 4 over No. 5, both in development and number of plants; phosphate of ammonia being used in the former, and sulphate in the latter. In No. 6, as compared with the two preceding, the amount of phosphoric acid is diminished, but in a greater degree. That of ammonia, to which body may be attributed an injurious effect upon the health of the plant when in excess, or not sufficiently incorporated with the soil, and a beneficial one after not only necessary diffusion has taken place, but the plants themselves have attained some strength and vigour. As might be expected, then the number of plants is greater, though the average weight of bulbs is less in No. 6 than in 4 and 5.

Comparing with each other Nos. 6 and 11, in which the amount of ammoniacal salts supplied by manure was identical, we find that an increase of superphosphate of lime by 1 cwt., and the addition of 4 cwt. of rape-cake (No. 11), whilst they reduced the number of plants from 14,256 to 10,320 (an effect certainly not due to the superphosphate of lime), at the same time raised the average weight of bulb from 0·65 to 1·29; showing the benefit of the supply of *organic matter* in those cases where it had not proved injurious or destructive to the plants, and the other conditions were such as to favour their healthy growth. Again, in No. 20, as compared with No. 11, the amount of supply by rape-cake is equal; that of ammoniacal

salt much greater; but that of the important constituent and agent, superphosphate of lime, is diminished. The result is a very great depreciation, not only in number of plants, but in the average weight of bulbs.

We have now given and examined the results of the first two seasons of our experiments upon the joint effects of climate and manures on the growth of the turnip bulb: and comparing the general character of the one season and its results with that of the other, we see, that although the climatic or vehicular and accumulative agencies were, during the largest portion of the time of growth, more favourable in 1844 than in 1843, yet the produce was, in the main, much inferior under the superior circumstances of climate. This can only be attributed to deficiency in some essential agency or supply, apart from those of season alone; and since those instances in this season, in which mineral supply is most liberal, show by the number of plants a degree of healthy condition, and yet an inferior rate of growth, we conclude that the soil was exhausted of matter for organic formations. That the defect is carbonaceous rather than nitrogenous, is learnt from a careful comparison of the effects of rape-cake and of ammoniacal salts.

Again, the conclusions elicited by a close examination of this second year's experiments, are seen to be identical in kind with those to which we were led by the first year's results; and in their degree afford even clearer testimony—rather than mere confirmation—on most of the points which had been previously discussed. It is the less important, however, to give a recapitulation in this place, as we have yet the entire results of the third season (1845) to detail; and, having accomplished that part of our task, we shall be prepared to give a *résumé* of the three years' series.

The destructive effects of some substances, when applied near to the seed, led us to sow the manures and the seed separately in the third year of our experiments. The same division into plots was observed as previously; but besides the drilled manures, which, though for the most part mineral, were sown before the seed, and at a somewhat greater depth, the entire series of plots was crossed by bands 72 yards in width; which were sown respectively with rape-cake, ammoniacal salt, and rape-cake and ammoniacal salt together, a sufficient portion being left having drilled manures only. These cross-dressings were sown broadcast, before the ridges first drawn out had been split and turned over, so that there could be little danger of injury to seed and young plants. By this arrangement of manuring, for each of the more than 20 conditions of 'ash-constituent' supply, 4 of varying

resource of matter for organic formations were secured; so that the number of experiments was raised to nearly 90.

It is to be regretted that in the first two seasons of our experiments, the acreage produce of leaf, and the relation of leaf to bulb, were not taken; as climate and manuring have a marked influence on the character of the turnip-crop in this respect, besides that which is known to depend upon the mechanical qualities of soil. A consideration of the relative and actual amount of leaf is moreover found to be of material importance in estimating the feeding value, degree of maturity, and probable resources of further growth of the plant. All the statement which we are able to give on this subject in reference to these two years is, that both the acreage weight of leaf, and the proportion of leaf to bulb, were much greater in 1843 than in 1844; there being in the former case a much more liberal provision of organic matter remaining in the soil, though, at the same time, a less amount of rain and a higher temperature. The leaves were weighed in the third year, and so far as the effects of different conditions of manuring, under the influence of one and the same season, are concerned, the results obtained are of some interest.

The results of the third year (1845) are given in 5 sections or divisions: and for the convenience of reference and examination, the statement of the manures is attached to each of these divisions. The different degrees of maturity exhibited under the influence of the varying supply for organic formations, provided by the cross-dressings, led us to weigh some of the crops at twice, that their progressive changes might be ascertained. The order of maturity which was observed was as follows:—1st. The lengths under drilled manures only (chiefly mineral). 2nd. Those having rape-cake added. 3rd. Those having ammoniacal salt added; and 4th. Those with both rape-cake and ammoniacal salt in addition to the mineral manures. The first weighing was taken in December, when the leaves under mineral supply had considerably drooped and changed colour; the rest exhibiting degrees of retained vitality in the inverse order indicated above. The second weighing was taken early in January, and three weeks later than the first, as will be seen on inspection of the tables.

	72 yards crossed with Rape-cake.	72 yards, crossed with Rape-cake and Ammoniacal Salt.	72 yards, crossed with Ammoniacal Salt.	110 yards, minerals only.	
1					1
2					2
3					3
4					4
5					5
6					6
7					7
8					8
9					9
10					10
11					11
12					12
13					13
14					14
15					15
16					16
17					17
18					18
19					19
20					20
21					21
22					22
23					23
24					24

The plan of the field given above will further show the method of manuring adopted in 1845. In the two previous years each experiment extended from one end of the field to the other; in 1845, 72 yards down the field was sown by hand across the rows respectively with rape-cake, equal to 10 cwt. per acre; 10 cwt. rape-cake and 3 cwt. sulphate of ammonia; 3 cwt. of sulphate of ammonia: the manures given as drilled manures were then drilled down the entire length of the field. Thus, from 3 to 24 inclusive, each space of land which was on experiment in 1843 and 1844 was, in 1845, divided into 4. The figures represent the same spaces of land each year. For example, No. 2 was unmanured in 1843 and 1844; in 1845 one part was unmanured, one was crossed with rape cake, one with rape-cake and ammoniacal salt, and one with ammoniacal salt. The plan adopted in 1845 has been continued in 1846 and 1847.

DIVISION 1.—QUANTITY of BULB per Acre, in Tons, cwts., qrs., and lbs.

Plot Numbers.	DESCRIPTION OF DRILLED MANURES. Quantities expressed in Weight per Acre.	Drilled Manures only.				Drilled Manures, and 10 cwt. Rape-cake, per Acre.				Drilled Manures, and 3 cwt. Sulphate of Ammonia per Acre. First Gathering				Drilled Manures, and 3 cwt. Sulphate of Ammonia per Acre. Second Gathering, (3 weeks later.)				Drilled Manures, with 10 cwt. Rape-cake and 3 cwt. Sulphate of Ammonia per Acre. First Gathering.				Drilled Manures, with 10 cwt. Rape-cake and 3 cwt. Sulphate of Ammonia per Acre. Second Gathering, (3 weeks later.)			
		Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts	qrs.	lbs.
1	12 tons farm-yard dung ridged in	17	0	3	6	.	.			14	18	3	12												
2	Unmanured	0	13	2	24	7	10	0	16	0	9	0	24	1	13	0	0	5	14	1	4	5	0	2	24
3	8 cwt. rape-cake	4	16	0	16	9	8	2	24	4	7	1	20	5	8	2	8	7	3	0	16	8	0	2	8
4	130 lbs. calcined bone-dust, 130 lbs. sulphate of ammonia, 130 lbs. hydrochloric acid (sp. gr. 1·18)	8	17	1	20	12	2	2	8	7	12	0	0	9	7	0	16	7	4	0	0	9	16	2	8
5	160 lbs. superphosphate of lime, 130 lbs. sulphate of ammonia	5	16	1	18	9	9	2	18	6	7	1	14	8	7	1	20	7	0	3	12	8	6	3	12
6	160 lbs. superphosphate of lime, 5 cwts. train oil	6	10	0	16	9	8	1	4	6	3	2	24	6	16	3	12	6	13	2	24	8	19	2	24
7	12 cwts. sulphate of lime (the refuse of tartaric acid manufacture)	5	13	2	24	18	1	0	0	4	15	1	20	4	8	1	4	7	3	1	20	8	10	2	8
8	400 lbs. calcined bone-dust	10	4	0	16	11	13	3	12	9	12	0	0	10	4	0	0	10	6	0	0	10	12	2	8
9	400 lbs. calcined bone-dust and hydrochloric acid (equivalent to 268 lbs. sulphuric acid, sp. gr. 1·70)	9	9	1	20	8	13	1	4	8	11	1	20	8	12	2	8	7	1	0	16	7	19	2	24
10	400 lbs. calcined bone-dust, 134 lbs. sulphuric acid	12	18	2	6	13	18	1	4	12	9	2	24	12	14	2	8	12	2	0	0	11	17	1	20
11	400 lbs. calcined bone-dust, 268 lbs. sulphuric acid	13	11	0	0	14	0	1	4	12	9	0	16	12	18	2	8	11	16	0	0	12	17	2	24
12	11 cwt. superphosphate of lime (land dug 9 inches deep in 1844)	13	8	2	8	14	5	1	4	12	11	0	16	12	14	0	0	11	4	1	4	13	9	1	20
13	400 lbs. calcined bone-dust, 268 lbs. sulphuric acid, 134 lbs. common salt	14	10	0	4	13	1	2	8	12	9	1	20	12	6	0	0	9	14	0	0	11	12	1	4
14	11 cwt. superphosphate of lime (land trenched 18 in. deep in 1844)	14	4	0	0	14	9	0	0	13	18	1	4	14	10	0	0	12	8	1	0	13	12	1	4
15	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 315 lbs. soda ash	11	15	3	12	12	8	3	12	12	8	2	8	13	0	0	0	11	3	1	20	11	13	2	24
16	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 220 lbs. magnesian limestone	12	1	0	0	14	3	2	24	12	14	3	12	12	19	0	16	11	17	2	24	13	4	2	8
17	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 470 lbs. pearlash	10	19	0	16	12	19	0	0	12	4	1	14	12	0	0	0	11	13	0	16	11	17	2	24
18	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 105 lbs. soda ash, 74 lbs. mag. limestone, 157 lbs. pearlash	12	12	2	8	13	18	2	24	12	16	3	22	13	12	0	0	13	1	3	6	13	15	1	20
19	As No. 18, with 1 cwt. sulphate of ammonia	12	7	0	0	11	5	2	8	10	0	3	12	10	16	1	4	9	16	0	0	11	8	2	8
20	As No. 18, with 3 cwt. rape-cake	14	7	2	8	14	6	0	0	12	8	2	10	13	8	0	0	12	9	2	24	12	18	0	0
21	400 lbs. calcined bone-dust, 400 lbs. sulphuric acid	13	2	2	24	14	8	1	20	11	13	1	20	12	6	0	0	12	4	0	0	13	4	2	8
22	11 cwt. superphosphate of lime	12	13	3	12	14	0	2	0	11	0	3	12	11	9	2	24	12	10	3	4	13	5	0	16
23	3 cwt. sulphate of ammonia	.	.			.	.			3	4	1	4												
24	Mean mixture of all other drilled manures, exclusive of Nos. 1 and 23	13	17	0	0	.	.			.	.														
	Mean Results	10	10	0	16	12	3	1	24	9	17	3	12	10	9	2	14	10	0	1	13	11	1	0	16

DIVISION 2.—QUANTITY of LEAF per Acre, in Tons, cwts., qrs., and lbs.

Plot Numbers.	DESCRIPTION OF DRILLED MANURES. Quantities expressed in Weight per Acre.	Drilled Manures only.				Drilled Manures, and 10 cwt. Rape-cake per Acre.				Drilled Manures, and 3 cwt. Sulphate of Ammonia per Acre. First Gathering.				Drilled Manures, and 3 cwt. Sulphate of Ammonia per Acre. Second Gathering, (3 weeks later.)				Drilled Manures, with 10 cwt. Rape-cake and 3 cwt. Sulphate of Ammonia per Acre. First Gathering.				Drilled Manures, with 10 cwt. Rape-cake and 3 cwt. Sulphate of Ammonia per Acre. Second Gathering, (3 weeks later.)			
		Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.
1	12 tons farm-yard dung, ridged in	7	7	3	2		. .			10	8	3	12												
2	Unmanured	0	14	1	4	4	16	2	24	0	6	2	16	0	18	0	0	4	16	0	0	4	10	0	0
3	8 cwt. rape-cake	4	5	0	0	8	9	1	4	4	14	1	4	4	6	2	8	8	8	1	6	7	18	3	12
4	130 lbs. calcined bone-dust, 130 lbs. sulphate of ammonia, 130 lbs. hydrochloric acid (sp. gr. 1·18)	4	9	1	4	6	6	0	16	6	7	0	16	5	12	0	0	8	2	0	0	6	14	2	8
5	160 lbs. superphosphate of lime, 130 lbs. sulphate of ammonia	4	8	1	4	6	0	2	24	6	6	3	12	6	0	1	4	8	4	0	0	7	15	0	16
6	160 lbs. superphosphate of lime, 5 cwt. train oil	3	0	3	12	4	9	1	20	5	4	0	0	4	14	6	12	7	5	0	16	5	19	1	20
7	12 cwt. sulphate of lime (refuse of tartaric acid process)	2	19	3	12	4	17	0	0	3	6	3	12	2	8	2	8	5	5	0	16	4	8	2	8
8	400 lbs. calcined bone-dust	3	12	3	12	5	8	1	20	6	12	1	4	5	2	3	12	7	14	3	12	5	17	2	24
9	400 lbs. calcined bone-dust, hydrochloric acid (=268 lbs. sulphuric acid, sp. gr. 1·70)	4	6	3	12	5	6	0	16	6	18	3	12	5	4	2	8	7	14	3	12	5	6	3	12
10	400 lbs. calcined bone-dust, 134 lbs. sulphuric acid	3	16	3	2	5	14	1	16	5	5	1	20	5	3	1	20	7	5	2	24	7	3	0	16
11	400 lbs. calcined bone-dust, 268 lbs. sulphuric acid	4	14	1	4	5	15	2	24	6	4	0	0	5	3	1	20	7	1	0	16	6	13	1	20
12	11 cwt. superphosphate of lime (land dug 9 in. deep in 1844)	4	9	0	0	5	16	2	8	6	18	1	4	5	9	3	20	8	8	2	8	7	2	3	12
13	400 lbs. calcined bone-dust, 268 lbs. sulphuric acid, 134 lbs. common salt	6	11	0	10	6	3	0	0	8	4	3	14	7	14	0	0	8	19	1	20	8	9	0	16
14	11 cwt. superphosphate of lime (land trenched 18 in. deep in 1844)	4	4	0	16	6	10	2	24	7	8	2	8	6	7	2	24	8	16	3	12	7	14	1	4
15	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 315 lbs. soda ash	3	10	2	14	5	2	0	16	8	0	1	4	5	12	3	12	8	8	2	8	6	12	2	8
16	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 220 lbs. magnesian limestone	3	17	1	4	4	15	0	18	6	6	2	8	5	8	3	12	7	3	2	24	6	8	0	0
17	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 670 lbs. pearlash	3	10	0	0	4	10	3	12	6	0	3	12	5	3	2	24	7	2	2	8	6	6	2	8
18	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 105 lbs. soda ash, 74 lbs. magnesian limestone, 157 lbs. pearlash	3	7	2	8	5	12	1	4	6	1	1	20	4	10	3	12	6	16	2	8	5	16	2	8
19	As No. 18, with 1 cwt. sulphate of ammonia	4	8	2	24	6	4	1	20	7	3	0	16	5	18	2	8	8	11	2	24	6	14	0	0
20	As No. 18, with 3 cwt. rape-cake	5	1	0	16	6	5	2	24	7	6	0	0	5	17	0	16	9	5	2	24	6	11	2	24
21	400 lbs. calcined bone-dust, 400 lbs. sulphuric acid	4	5	0	16	6	3	0	0	6	15	1	20	5	0	3	12	6	18	0	0	7	18	3	8
22	11 cwt. superphosphate of lime	4	8	0	0	6	0	0	0	7	0	2	8	5	0	3	12	6	8	2	24	6	13	1	20
23	3 cwt. sulphate of ammonia		. .				. . .			1	14	0	8		. .										
24	Mean mixture of all other drilled manures, exclusive of Nos. 1 and 23	3	3	1	2		. .				. .				. .										
	Mean Results	4	0	0	6	5	14	2	17	6	2	2	0	5	1	3	17	7	11	1	7	6	12	1	13

Division 3.—Average Weight of Bulbs, in Pounds and Tenths.

Plot Numbers.	Description of Drilled Manures. Quantities expressed in Weight per Acre.	Drilled Manures only.	Drilled Manures, and 10 cwts. Rape Cake per Acre.	Drilled Manures, and 3 cwts. Sulphate of Ammonia per Acre.		Drilled Manures, with 10 cwts. Rape-cake and 3 cwts. Sulphate of Ammonia per Acre.	
				First Gathering.	Second Gathering (3 weeks later).	First Gathering.	Second Gathering (3 weeks later).
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	12 tons farm-yard dung, ridged in	1·61	..	1·45	..	..	..
2	Unmanured	0·11	0·67	0·066	0·22	0·50	0·49
3	8 cwts. rape-cake	0·49	0·87	0·47	0·55	0·56	0·80
	130 lbs. calcined bone dust, 130 lbs. sulphate of ammonia, 130 lbs. hydrochloric acid (sp. gr. 1·18)	0·92	1·14	0·77	0·89	0·81	0·98
	160 lbs. superphosphate of lime, 130 lbs. sulphate of ammonia	0·90	1·04	0·77	0·95	0·72	0·87
	16) lbs. superphosphate of lime, 5 cwts. train oil	0·59	0·90	0·55	0·62	0·64	0·86
7	12 cwts. sulphate of lime (refuse of tartaric acid manufacture)	0·59	0·94	0·54	0·46	0·68	0·89
8	400 lbs. calcined bone dust	0·92	1·10	0·94	0·95	0·97	1·00
9	400 lbs. calcined bone dust, hydrochloric acid (= 268 lbs. sulphuric acid, sp. gr. 1·70)	1·02	1·16	0·99	0·99	0·87	0·96
10	400 lbs. calcined bone dust, 134 lbs. sulphuric acid	1·18	1·33	1·25	1·20	1·10	1·14
11	400 lbs. calcined bone dust, 268 lbs. sulphuric acid	1·23	1·38	1·19	1·22	1·11	1·22
12	11 cwts. superphosphate of lime (land dug 9 inches deep in 1844)	1·20	1·39	1·19	1·23	1·07	1·25
13	400 lbs. calcined bone dust, 268 lbs. sulphuric acid, 134 lbs. common salt	1·38	1·27	1·16	1·20	1·03	1·13
14	11 cwts. superphosphate of lime (land trenched 18 inches deep in 1844)	1·30	1·33	1·30	1·37	1·19	1·26
15	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 315 lbs. soda ash	1·11	1·37	1·14	1·17	1·10	1·16
16	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 220 lbs. magnesian limestone	1·11	1·35	1·21	1·25	1·14	1·23
17	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 470 lbs. pearlash	1·02	1·27	1·16	1·09	1·13	1·08
18	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 105 lbs. soda ash, 74 lbs. magnesian limestone, 157 lbs. pearlash	1·16	1·33	1·18	1·24	1·25	1 29
19	As No. 18, with 1 cwt. sulphate of ammonia	1·16	1·24	1·02	1·09	1·09	1·15
20	As No. 18, with 3 cwts. rape-cake	1·28	1·40	1·18	1·29	1·18	1·23
21	400 lbs. calcined bone dust, 400 lbs. sulphuric acid	1·22	1·41	1·10	1·15	1·18	1·20
22	11 cwts. superphosphate of lime	1·17	1·33	1·06	1·24	1·17	1·24
23	3 cwts. sulphate of ammonia	..	..	0·37	..	..	..
24	Mean mixture of all the other drilled manures, exclusive of Nos. 1 and 23	1·27	..	..	..	..	..
	Mean results	1·00	1·20	0·96	1·02	0·98	1·07

DIVISION 4.—NUMBER OF PLANTS per Acre.

Plot Numbers.	DESCRIPTION OF DRILLED MANURES. Quantities expressed in Weight per Acre.	Drilled Manures, only.	Drilled Manures and 10 cwts. Rape-cake per Acre.	Drilled Manures, and 3 cwts. Sulphate of Ammonia per Acre.		Drilled Manures, with 10 cwts. Rape-cake and 3 cwts. Sulphate of Ammonia per Acre.	
				First Gathering.	Second Gathering (3 weeks later).	First Gathering.	Second Gathering (3 weeks later).
1	12 tons farm-yard dung, ridged in	23,731	..	23,104	..	..	..
2	No manure	13,296	24,944	15,456	16,848	24,160	23,088
3	8 cwts. rape-cake	21,952	24,240	20,896	22,016	20,544	23,304
4	130 lbs. calcined bone dust, 130 lbs, sulphate of ammonia, 130 lbs. hydrochloric acid (sp. gr. 1·18).	24,000	23,712	22,368	23,488	20,000	22,496
5	160 lbs. superphosphate of lime, 130 lbs. sulphate of ammonia	14,544	20,448	19,296	19,776	21,824	21,472
6	160 lbs. superphosphate of lime, 5 cwts. train oil	24,528	23,632	24,992	24,576	23,264	23,424
7	12 cwts. sulphate of lime (the refuse of tartaric acid manufacture)	21,408	23,952	19,584	21,376	23,488	23,616
8	400 lbs. calcined bone dust	21,896	23,760	22,944	24,132	23,808	23,872
9	400 lbs. calcined bone dust and hydrochloric acid (= 268 lbs. sulphuric acid, sp. gr. 1·7)	20,784	16,672	19,360	19,584	18,272	18,624
10	400 lbs. calcined bone dust and 134 lbs. sulphuric acid	24,704	23,456	22,368	23,808	24,576	23,360
11	400 lbs. calcined bone dust and 268 lbs. sulphuric acid	24,624	22,800	23,360	23,712	23,872	23,744
12	11 cwts. superphosphate of lime (land dug 9 inches deep in 1844)	25,120	23,072	23,606	23,136	23,520	24,160
13	400 lbs. calcined bone dust, 268 lbs. sulphuric acid, 134 lbs. common salt	23,620	23,104	24,128	23,040	21,152	23,008
14	11 cwts. superphosphate of lime (land trenched 18 inches deep in 1844)	24,464	24,368	23,936	23,872	23,328	24,224
15	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 315 lbs. soda ash	23,792	20,384	24,352	24,960	22,720	22,592
16	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 220 lbs. magnesian limestone	24,336	23,470	23,584	23,200	23,456	24,032
17	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 470 lbs. pearlash	24,160	22,800	23,648	24,608	23,200	24,544
18	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 105 lbs. soda ash, 74 lbs. magnesian limestone, 157 lbs. pearlash	24,448	23,404	24,448	24,480	23,392	24,000
19	As No. 18, with 1 cwt. sulphate of ammonia	23,888	20,448	22,112	22,304	20,222	22,304
20	As No. 18, with 3 cwts. rape-cake	25,120	22,896	23,680	23,200	23,680	23,552
21	400 lbs. calcined bone dust, 400 lbs. sulphuric acid	24,160	22,912	23,712	23,904	23,168	24,608
22	11 cwts. superphosphate of lime	24,352	23,544	23,424	20,800	23,936	23,872
23	3 cwts. sulphate of ammonia	..	..	19,328	..	..	..
24	Mean mixture of all the other drilled manures, exclusive of Nos. 1 and 23	24,352	..	..	..	..	..
	Mean results	22,962	22,763	22,440	22,705	23,028	23,233

Division 5.—Proportion of Leaf to Bulb; Bulb as 1000.

Plot Numbers.	Description of Drilled Manures. Quantities expressed in Weight per Acre.	Drilled Manures only.	Drilled Manures, and 10 cwts. Rape-cake per Acre.	Drilled Manures, and 3 cwts. Sulphate of Ammonia per Acre.		Drilled Manures, with 10 cwts. Rape-cake and 3 cwts. Sulphate of Ammonia per Acre.	
				First Gathering.	Second Gathering (3 weeks later).	First Gathering.	Second Gathering (3 weeks later).
1	12 tons farm-yard dung, ridged in; no drilled manures	433	..	698	..	..	..
2	No manure	1,041	644	720	545	840	892
3	8 cwts. rape-cake	884	896	1,078	797	1,176	909
4	130 lbs. calcined bone dust, 130 lbs. sulphate of ammonia, 130 lbs. hydrochloric acid (sp. gr. 1·18)	452	520	837	592	1,126	704
5	160 lbs. superphosphate of lime, 130 lbs. sulphate of ammonia	758	636	943	718	1,164	930
6	160 lbs. superphosphate of lime, 5 cwts. train oil	467	475	840	693	1,085	664
7	12 cwts. sulphate of lime (refuse of tartaric acid manufacture)	526	482	700	550	737	519
8	400 lbs. calcined bone dust	356	463	686	504	741	553
9	400 lbs. calcined bone dust, hydrochloric acid (= 268 lbs. sulphuric acid)	458	612	809	606	1,009	669
10	400 lbs. calcined bone dust, 134 lbs. sulphuric acid	296	410	422	445	602	602
11	400 lbs. calcined bone dust, 268 lbs. sulphuric acid	348	412	492	438	580	512
12	11 cwts. superphosphate of lime (land dug 9 inches deep in 1844)	331	408	550	467	751	530
13	400 lbs. calcined bone dust, 268 lbs. sulphuric acid, 134 lbs. common salt	451	470	666	626	925	727
14	11 cwts. superphosphate of lime (land trenched 18 inches deep in 1844)	296	452	533	440	712	560
15	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 315 lbs. soda ash	299	410	644	434	754	561
16	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 220 lbs. magnesian limestone	320	335	496	420	604	483
17	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 470 lbs. pearlash	319	350	494	432	611	532
18	400 lbs. calcined bone dust, 420 lbs. sulphuric acid, 105 lbs. soda ash, 74 lbs. magnesian limestone, 157 lbs. pearlash	267	402	472	334	521	423
19	As No. 18, with 1 cwt. sulphate of ammonia	264	551	712	549	876	586
20	As No. 18, with 3 cwts. rape-cake	351	439	587	437	743	510
21	400 lbs. calcined bone dust, 400 lbs. sulphuric acid	324	426	580	375	509	600
22	11 cwts. superphosphate of lime	345	427	636	456	512	505
	Mean results	416	486	634	521	789	617

With such a mass of experimental evidence before us, it is difficult to select a starting-point such as will lead us to the most natural order of illustration, and the clearest comprehension of their most prominent indications and conclusions. In many respects these results are most interesting, confirming as they do the opinions suggested by those which have preceded them; and affording at the same time data, the consideration of which enables us to determine other important questions than those already attended to.

It will be recollected that the statement given of the character of this third season, compared with that of the second, was, so far as all the conditions shown to be essential to the vigorous growth of the turnips were concerned, very much in favour of the one about to occupy our attention; and it is seen that the acreage produce is pretty uniformly nearly doubled where artificial supply for organic formations is much the same. It is true that the number of plants per acre being much greater than heretofore, some of the actual acreage increase may be attributed to this cause; but all we wish to maintain is the general effect of season upon the growth of the cultivated turnip.

The absolute necessity of a liberal supply of *constituents,* even with the most favourable climatic circumstances, and under the influence of the best observed conditions of self-reliance, or collective power depending on mineral supply, is, however, clearly proved by the results of the farm-yard dung, the unmanured plot, and the mean of the purely mineral manures. They are here given in illustration.

Selected Results.

Description of Manures.	Bulb per Acre, in				Average weight of Bulbs in lbs. and tenths.	Number of Plants per Acre.
	Tons.	cwts.	qrs.	lbs.		
Unmanured	0	13	2	24	0·11	13,296
Mean by purely mineral supply . . .	12	8	2	3	1·16	23,882
Farm-yard dung	17	0	3	6	1·61	23,731

Thus, in the best suited of the three seasons to which our experiments refer, the unmanured plot gives a produce of only 13 cwts. per acre, an average weight of bulb under 2 ounces, and a number of surviving plants little more than half that observed under conditions of artificial supply. In this same season, on the other hand, the farm-yard dung gives the largest acreage produce obtained throughout the entire series of seasons and experiments, a weight of bulb higher than any other manure in the same

season, and a number of plants nearly identical with that under mineral manures only. Again, by mineral supply alone, to which, indeed, as we have seen, may be attributed an influence upon the growth of the plant apart from that which can be traceable to the mere provision of *crop-material,* we have as many tons of produce as the unmanured plot gives cwts., a weight of bulb more than ten times as great, and a number of healthy plants nearly double. By the side of the farm-yard dung, however, which we presume to contain a sufficiency of *all the constituents* of a large crop of turnips, (though, excepting under the influence of continuity of rain and a relatively low temperature, not calculated to develop the most healthy conditions of growth,) we find that the purely mineral manuring, with a number of plants per acre almost identical, shows a formation of bulb within an equal period of time little more than two-thirds as great. We shall presently see that the largest weight of *bulb formed in a given time* is not to be taken as affording an unconditional index to the value or promise of the crop; but in the instances now cited it may, in a pre-eminent degree, be quoted as such; for we know that whilst the plants under minerals only had, when weighed, arrived at their full growth, those having farm-yard dung had still vitality and resources.

Before tracing any further the probable source of the superiority of farm-yard over the purely mineral manures, we will refer to some other of the points which our arrangement of manuring elucidates. In the two former years it was observed that, wherever either ammoniacal salts or rape-cake were drilled with the seed, a great depreciation and irregularity in the number of plants per acre resulted; and it may have appeared to some of our readers that we have, without sufficient ground, referred the deficiency of plants to the manner of applying these organic manures; and that, omitting the indications of the actual acreage results, our reasonings are fallacious. The following summary of the number of plants obtained, when ammoniacal salts and rape-cake are sown broadcast and ploughed in, and of that resulting from the use of mineral manures alone, will show how highly important it is not only to select a manure such as the plant requires, but so to apply it as to ensure a beneficial rather than an injurious result.

The uniformity under the various classes of manures in this season, as compared with others, is very striking; though, as before, the mineral manure gives somewhat the higher number. The coincidence throughout the entire series of about 90 different combinations of manures (see Division 4 of Table) is such that, for the first time, the acreage amount of produce may be taken as a somewhat true measure of the value of the manures. The drilled

manures, as has already been stated, were this year sown alone before the seed, yet the detailed results given in division 4 of the Table still afford instances of the injurious effect arising from the proximity to the plant of certain manures, though in so slight a degree as to be almost immaterial.

SUMMARY.*

Description of Manures.	Number of Plants per Acre.
Mean of mineral manures alone	23,882
„ „ with rape-cake added	22,596
„ „ with ammoniacal salt added	23,598
„ „ with both rape-cake and ammoniacal salt	22,954

The influence of climatic condition, not only as of itself a source of constituents, but as rendering available the supplies provided by the farmer, is strikingly illustrated by the details next quoted: wherein it is seen that notwithstanding the comparatively large number of plants in 1845, which might be supposed to prevent individual development, there is a marked increase as compared with 1844.

Description of Manures.	Number of Plants per Acre.		Average weight of Bulbs.	
	1844.	1845.	1844.	1845.
Farm-yard dung	20,096	23,731	1·19	1·61
Mean of purely mineral manures	20,377	23,882	0·73	1·16

It is here seen that, even with so great a number of plants, the average weight of bulb is very considerably higher in 1845 than in 1844. In the case of the dung the supply by manure is not supposed to be better than in 1844. In the case of the mineral manures, however, the quantities were larger than before; but the accumulation of organic constituents must have been almost entirely from atmospheric resources. A comparison of the results of the one year with those of the other, as given above, sufficiently prove then the essential influence of climatic agency for the development of the turnip-bulb in *full agricultural quantity;* but the great defect in formation of bulb within a given

* It will be remembered that in former years the plants were set out with the view of retaining about four to a square yard, or 19,360 upon an acre; the design in this third year was to increase the number to about five instead of four, which is equal to 24,200 to the acre, and hence the actual numbers in the table just given are much htgher than hitherto.

time, under the influence of one and the same season, when a full supply of mineral manure only is provided, as compared with that of organic matter, also again teaches how imperative it is that there be a liberal provision of such matter in the soil, if we would produce the largest crop which the characters of the season admit of.

The results already selected from the table do not, however, show us whether this required supply by manure of matter for organic formations should be more prominently nitrogenous, as in the case of wheat, or *carbonaceous*. This point we shall presently recur to; but, before doing so, shall study the effects of varying the mineral supply by manure.

The average weight of bulb, as effected by the amount of *free* phosphoric acid, or superphosphate of lime, supplied to the soil by manures, is here given :—

Plot Nos.	Description of Drilled Manures.	Average weight of Bulbs, in lbs.			
		Drilled Manures only.	Drilled Manures, and 10 cwt. Rape-cake per Acre.	Drilled Manures, and 3 cwt. Sulph. Am. per Acre.	Drilled Manures, and 10 cwt. Rape-cake and 3 cwt. Sulph. Am. per Acre.
8	400 lbs. calcined bone-dust . . .	0·92	1·10	0·96	0·97
9	400 lbs. calcined bone-dust and hydrochloric acid = 268 lbs. sulphuric acid	1·02	1·16	0·99	0·87
10	400 lbs. calcined bone-dust and 134 lbs. sulphuric acid	1·18	1·33	1·25	1·10
11	400 lbs. calcined bone-dust and 268 lbs. sulphuric acid	1·23	1·38	1·19	1·11
21	400 lbs. calcined bone-dust and 400 lbs. sulphuric acid	1·22	1·41	1·10	1·18
	Mean of the results by sulphuric acid	1·21	1·37	1·18	1·13

It is seen that, under all the varying conditions of organic supply, the undecomposed bone-dust produced less effect than the decomposed. Hydrochloric acid has caused a slight increase in bulb where there was no organic manure, and where rape-cake or ammoniacal salt only was added; but where ammoniacal salt and rape-cake were employed together, the formation of bulb was less than by undecomposed bone-dust. But a reference to division 2 of the Table of collected results will show, however, a much larger quantity of leaf under the action of hydrochloric acid,—and, in fact, there was more general growth than by undecomposed bone-dust, though but little tendency to form bulb; yet there is little doubt that eventually, if allowed to mature, the

decomposed bone-earth would have given much the largest amount of bulb as well as entire plant.

Sulphuric acid, as the decomposing agent, indicates in every case a considerably more rapid determination to bulb than either the undecomposed earth or that acted upon by the hydrochloric acid; and, excepting where ammoniacal salt is superadded, there is a perceptible progression as the amount of acid is increased. Where the ammoniacal salt was used, though the formation of *bulb* is not greater under an increase of acid, there was here, as in the case of the hydrochloric acid, a larger development of *leaf*.

The effect of an equal amount of superphosphate of lime on land ploughed in the ordinary way, or which had been dug 9 or 18 inches deep in the previous year, is here shown :—

Plot Nos.	Land, how Tilled.	Average weight of Bulbs.			
		Drilled Manures only.	Drilled Manures, and 10 cwt. Rape-cake per Acre.	Drilled Manures, and 3 cwt. Sulph. Am. per Acre.	Drilled Manures, and 3 cwt. Sulph. Am and 10 cwt Rape-cake per Acre.
12	Land dug 9 inches in 1844 (11 cwt. superphosphate of lime) . . .	1·20	1·39	1·19	1·07
14	Land dug 18 inches in 1844 (11 cwt. superphosphate of lime) . . .	1·30	1·33	1·30	1·19
22	Land only ploughed (11 cwt. superphosphate of lime)	1·17	1·33	1·06	1·17

Excepting in column 2, the rapidity of bulb-formation is slightly the greatest where the land is deeply trenched, and in the exceptional case a larger development of leaf was found. The land dug 9 inches deep also shows a slight superiority over that which was only ploughed. The differences are not quoted as offering any adequate advantage for so expensive a process as spade-digging; but the facts themselves help to indicate the character of the conditions required in turnip culture.

We shall next show the result of the yearly supply of *alkalis*, compared with that from a plot (No. 21) which had been drained of them by a course of ordinary cropping, succeeded by the removal of two crops of turnips :—

In the first two columns, where, as we shall presently show, the *balance* of organic constituents was more favourable to *bulb*-formation than in the other cases, we find a greater development of bulb in an equal period of time by superphosphate of lime alone, than when the alkalis, either separately or united, were supplied with it. It is remarkable, too, that in No. 17, where *potass* was employed, there is a general inferiority observable. Again, of

Plot Nos.	Description of Alkaline Manures (drilled).	Drilled Manures only.	Drilled Manures, and 10 cwt. Rape-cake per Acre.	Drilled Manures, and 3 cwt. Sulph. Am. per Acre.	Drilled Manures, 3 cwt. Sulph. Am. and 10 cwt. Rape-cake per Acre.
21	400 lbs. calcined bone-dust and 400 lbs. sulphuric acid	1·22	1·41	1·10	1·18
15	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, and 315 lbs. soda ash	1·11	1·37	1·14	1·10
16	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, and 220 lbs. magnesian limestone	1·11	1·35	1·21	1·14
17	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, and 470 lbs. pearl-ash	1·02	1·27	1·16	1·13
18	400 lbs. calcined bone-dust, 105 lbs. soda ash, 74 lbs. magnesian limestone, and 157 lbs. pearlash . .	1·16	1·33	1·18	1·25
	Mean by alkaline supply . .	1·10	1·33	1·17	1·15

the several alkaline conditions, that where potass, soda, and magnesia are used together is the best. The differences exhibited are at any rate sufficient to show that there was no advantage derived by the use of alkaline manures in this soil, which had been subjected to an unusually severe exhaustion of them.

We have, indeed, uniformly observed, not only in the case of turnips, but of other plants, that by the direct supply of alkalis no good effect has resulted in the season of the application, though the succeeding crops have apparently, to a small extent, been benefited. It is our opinion that, in the ordinary course of farming, the special supply of alkalis to the soil is exceedingly rarely requisite,—and, if ever it be so, they should never be applied in an *alkaline condition* (which seems to be very prejudicial to healthy vegetation), but always supersaturated by acids. Further, alkalis should not be drilled, but should always be sown broadcast, and well incorporated with the soil. In the case of turnips especially is this to be carefully attended to; and, indeed, it might be almost laid down as a general rule, that those manuring substances which take their value as *mere* constituents of the plant (alkalis and organic manures), should be well distributed through the soil; and those which further exercise an influence upon the health and vigour of the plant, such as superphosphate of lime, should be drilled near the seed.

Whether or not superphosphate of lime owes much of its effect to its chemical actions in the soil, it is certainly true that it causes a much-enhanced development of the *underground* collective apparatus of the plant, especially of *lateral* and *fibrous* root, distribut-

ing a complete network to a considerable distance around the plant, and throwing innumerable mouths to the surface. The extent and direction of the *underground range* of the turnip are at the same time very much dependent on the mechanical condition of the soil; and it is universally known that *tilth* is of the highest importance to the favourable formation of *bulb*. We know that the best relation of bulb to leaf, and, in fact, the best acreage produce of bulbs is in the lighter soils, where there is comparatively little obstruction to the development of fibrous root, and it is in these that the special efficacy of superphosphate of lime has been most observable. We believe that, if the turnip is to be valued for its *bulb-formation*, the aim of our culture must be, not to increase the aboveground organs of collection (the leaves), but the *underground fibrous roots*.

We shall now consider the effects of "*organic manures*" upon the production of turnip bulb; and the facts that will come before us will tend to confirm the views just maintained regarding the essential development of rootlet rather than leaf accumulation, as a means of obtaining the turnip in agricultural quantity and quality.

The results collected below will illustrate some of the effects of "organic manures" upon the growth of the turnip:—

Description of Mineral Manures.	Mineral Manures only.	Mineral Manures, and 10 cwt. Rape-cake per Acre.	Mineral Manures, and 3 cwt. Sulph. Am. per Acre.	Mineral Manures, 10 cwt. Rape-cake and 3 cwt. Sulph. Am. per Acre.
Mean of entire series of purely mineral manures	1·16	1·31	1·14	1·10
Mean of four experiments with alkaline supply	1·10	1·33	1·17	1·15
Mean of three experiments with superphosphate of lime	1·21	1·37	1·18	1·13

We may explain that the results in the first column were obtained by means of mineral manures alone, and that, the previous crops having been entirely removed from the land, the organic supplies must have been chiefly derived from the atmosphere. The development of *leaf* was less in these than in any of the other cases. In column 2 there was, besides these same mineral manures, 10 cwts. rape-cake, which may be estimated to provide perhaps 50 lbs. of nitrogen. It was, however, employed in these experiments as supplying a large amount of carbonaceous matter, in which it abounds. In the 3rd column the effects are due to the addition of 3 cwts. of sulphate of ammonia to the mineral manures. In these cases about 60 lbs. of nitrogen is supplied,

but no carbon. In the 4th column we have the effects of the addition both of the rape-cake and of the ammoniacal salt to the standard mineral manure; consequently the supply of nitrogen by manure would amount to about 110 lbs. per acre.

It is seen that, whichever mineral condition be taken, the supply of carbonaceous matter has given the largest bulb. Of the two mineral series, the acid and the alkaline, the former exhibits a general superiority in each case, excepting in the 4th column, where the defect is very trifling. In this case, notwithstanding there was a carbonaceous supply equal to that in column 2, the excessive amount of *nitrogenous* matter has prevented a favourable formation of bulb. These mean results clearly show that carbonaceous rather than nitrogenous organic supply is favourable to *bulb-formation,* and the fact is confirmed by the following individual cases:—

SELECTED RESULTS.

Plot Nos.	Description of Drilled Manures.	Drilled Manures only.	Drilled Manures, and 10 cwt. Rape-cake per Acre.	Drilled Manures, and 3 cwt. Sulph. Am. per Acre.	Drilled Manures, 10 cwt. Rape-cake and 3 cwt. Sulph. Am. per Acre.
18	Superphosphate of lime, with potass, soda, and magnesia	1·16	1·33	1·18	1·25
19	As No. 18, and 1 cwt. sulphate of ammonia	1·16	1·24	1·02	1·09
20	As No. 18, and 3 cwt. rape-cake . .	1·28	1·40	1·18	1·18

In all these cases the mineral manure was the same, and in all, the 2nd column under the cross-dressing of rape-cake shows the best result. Further, looking at each column separately, we find that No. 20 always gives a heavier bulb than No. 19, and, excepting under the cross-dressings of ammoniacal salt, than No. 18 also. The amount of the differences is not indeed great; but when we remember that the results are calculated from nearly 2000 plants in each case, their uniformity and constancy demand that reliance should be placed in them. It is clear, then, that carbonaceous manures aid the development of turnip *bulb.* We shall give one more quotation on this subject:—

	No Cross-dressing.	Cross-dressed by 10 cwt. Rape-cake per Acre.	Cross-dressed by 3 cwt. Sulphate Ammonia per Acre.	Cross-dressed by 10 cwt. Rape-cape and 3 cwt. Sulph. Am. per Acre.
No drilled manure (third season) . . .	0 11	0·67	0·07	0·50

The instances before us are of high interest in many points of

view, but we are not prepared to consider them fully until we have detailed the results of an analytical examination of the crops—a subject which we shall presently enter upon. Resuming the question in discussion, we see that whilst ammoniacal salts in no degree restored fertility to this exhausted soil, rape-cake gave a sixfold development. In the 4th column, under an equal amount of rape-cake, we find as usual that the excess of nitrogenous manure has deteriorated the tendency to bulb formation exhibited in column 2.

The contrast observed in the effects of ammoniacal salts upon wheat and upon turnips is very remarkable, and affords a striking illustration of the widely differing requirements and sources of growth of the corn-exporting "white crops" and the home-consumed, meat-producing "green" or "fallow crops," of which classes respectively the two plants may be considered as the types.

Hitherto we have only considered the effects of organic manures upon the formation of turnip *bulb*, the amount of which is thought to determine the value of the crop when cultivated for feeding and rotation purposes. It has been seen that a liberal supply of available phosphates and of organic manures abounding in carbonaceous matter are pre-eminently favourable to the desired habit of the plant, and that nitrogenous supply, so essential to the increased growth of corn, is so here only to a very limited extent. Under the influence of ammoniacal manures, however, the production of turnip *leaf* is much enhanced, as the following results will show:—

Description of Manures.	Bulb per Acre, in				Leaf per Acre, in				Proportion of Leaf to 1000 of Bulb.
	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	
Mean by purely mineral manures.	12	8	2	3	4	4	0	14	326
Mean of mineral manures, with 10 cwt. rape-cake added . .	13	4	2	20	5	12	0	21	421
Mean by mineral manures, and 3 cwt. sulphate of ammonia added	11	18	1	24	6	15	0	21	559
Mean by mineral manures, and 3 cwt. sulphate of ammonia (second gathering)	12	5	0	13	5	14	0	17	466
Mean by purely mineral manures, and both rape-cake and ammoniacal salt	11	6	1	11	7	9	0	22	669
Mean by purely mineral manures, and both rape-cake and ammoniacal salt (second gathering) .	12	4	3	6	6	15	2	16	554

Thus comparing lines 1 and 3, we find that whilst, by the addition of ammoniacal salt in the latter case, there is in an equal

space of time half a ton less of bulb, there is an increase in leaf by $2\frac{1}{2}$ tons; and, as shown in the 3rd column, the proportion of leaf to bulb is more than half as much again. Taking lines 2 and 5, the addition of ammoniacal salt, as in 5, gives nearly 2 tons less bulb, but nearly 2 tons more leaf, the proportion of leaf to bulb being again increased by one-half. The gross produce is seen therefore to be greater in one of these cases, and as great in the other, under the addition of ammoniacal salts. We have before remarked, however, that whilst at the time of gathering, the crops by mineral manures alone, as in line 1, had probably more than fully arrived at maturity—the leaves having drooped and changed colour—those under rape-cake addition only had but just attained full growth, and those having ammoniacal salts, as in lines 3 and 5, evidently possessed yet unexhausted vitality, especially in No. 5, the case where rape-cake was also supplied. It might be supposed, therefore, that in due course bulbous development would succeed as the increased leaves drooped. The results of the second gathering, taken when the leaves under ammoniacal salt without rape-cake had considerably fallen (those with it being still vigorous), show this to have been the case to a greater or less degree. A comparison of lines 3 and 4 shows an increase of bulb in three weeks of 7 cwt., at the expense of 19 cwt. of fresh weight of leaf. On the other hand, line 6 gives an increase in the same period of $18\frac{1}{2}$ cwt. of bulb, at the expense of only 14 cwt. of fresh leaf. Under ammoniacal salts alone there had therefore been an actual depreciation in fresh weight, indicating at least a loss of vitality, though there was probably no real loss of solid matter. Where there was rape-cake also, however, we find an actual gain in gross weight, and we had undoubtedly a vitality and resource of growth still unexhausted. Comparing line 4 with line 1, the latter has still the largest weight of bulb; and comparing line 6 with line 2, the former is still a ton in advance. Were we to admit, however, that if the crops could have been taken each at the stage of its best yield of *bulb*, there would have been a slight superiority under the nitrogenous manuring, the quantity yielding the effect in these instances could in no form have been economically obtained, even were there no other objection to its use.

The effects of an excess of nitrogen in tending to an unprofitable habit of the plant are further exhibited in page 532 :—

It is here seen that whilst farm-yard dung, itself containing some nitrogen, and certainly a very full allowance of carbonaceous matter, gives 17 tons of bulb, we have more than 2 tons less bulb when ammoniacal salt is superadded; but there are at the same time 3 tons more leaf than by dung alone. The 3rd column shows that the actual size of bulb, as well as its acreage produce,

	Bulb per Acre, in				Leaf per Acre, in				Average Weight of Bulbs.	Proportion of Leaf to 1000 of Bulb.
	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.		
12 tons farm-yard dung .	17	0	3	6	7	7	3	2	1·61	433
12 tons farm-yard dung, and 3 cwt. sulphate of ammonia	14	18	3	12	10	8	3	12	1·45	700

was less, under the excessive supply of nitrogen; the 4th, that under the same circumstances the proportion of leaf to bulb was increased by more than one-half. So far as supply of *constituents* is concerned, we could select from the series of experiments several instances where we may reasonably suppose that every constituent, excepting *carbon*, existed more fully in quantity and more favourably in combination than in the dung, yet with its larger *carbonaceous supply to the root* we get the largest crop of bulb in the series. The excess of nitrogenous manure, however, is seen greatly to enhance the leaf-forming tendencies of the plant, which it is true may probably aid carbonic acid accumulation from the atmosphere, but at the same time gives a less profitable appropriation of the resources within the soil; and we shall afterwards see it to be by no means clear that there is with a large production of leaf a proportional *gain* of nitrogen from the atmosphere.

Admitting, then, that the organic manure required for the growth of turnip *bulbs* should be carbonaceous rather than nitrogenous, there is still evidence that, under the influence of a due provision of nitrogen, the vitality or longevity of the plant is greatly increased; and since the turnip crop is required to brave the winter frosts, an early and perfect ripening, such as would be induced by a defect of nitrogen relatively to carbon, whilst it might be coincident with a more *rapid* bulb formation, would by no means be a desideratum. We believe, however, that in the ordinary course of farming, the special supply of nitrogen to the turnip crop, by means of artificial manures, is seldom if ever necessary; for there is no ample source of available carbon which does not provide at the same time a considerable amount of nitrogen. As therefore, in the case of wheat, we need not study the supply of carbonaceous manures, so, in the case of turnips, it comes to be unnecessary to devote special care to the provision of nitrogen. In the one case the means adopted specially to secure nitrogen to the soil, brings with it enough of carbon; and in the other the peculiarly carbonaceous manures are associated with sufficient nitrogen.

We have argued that for the growth of turnip-*bulb* a soil is

required in such a mechanical condition as shall render it easily permeable to the atmosphere and to the fibrous roots of the plants,—that healthy action and a tendency to development of very extended underground collective apparatus should be induced by the use of the so-called "mineral manures," these never being in an alkaline state, and always containing a considerable quantity of phosphoric acid easily available to the plant,—that after the early stages of the plant are passed, its rapidity of growth depends upon an abundant provision *in the soil* of constituents for organic formations, especially of *carbon*,—that nitrogen must be provided by cultivation, though seldom by special manures,—and lastly, that all these requisites being provided by the farmer, the degree in which his efforts will be availing depends essentially upon certain climatic conditions, comprising a considerable *continuity* and *amount* of rain as a means of taking up the stores of the soil, keeping up a vigorous circulation in the plant, and supplying the dissolved gases of the atmosphere.

These conditions compared with those which are required in the culture of wheat are opposed to one another in almost every particular, but as we proceed we shall see, that of the observed differences much is doubtless due to the essential distinctions between the tendencies of the natural families to which the plants belong; yet much of it is also attributable to the fact, that in the case of the turnip it is not the seed that is the object of our culture, but a monstrous accumulation which could only take place under a somewhat unnatural or artificial balance of the constituents of supplied food, and under such a condition of climate as should be adverse to seed-forming.

It is known that where the turnip is grown for its natural seed-product, oil, a heavier soil, richer manuring, and, during a considerable period of the growth of the plant, a much higher temperature, are required than when the bulb is to be produced. Under these circumstances there will be much less fibrous root thrown up to the surface,—the root is scarcely bulbous, but fusiform, tapping rather than spreading laterally; the leaves and stem are much larger, both actually and proportionally to the root, and the organic manures should contain more nitrogen and less carbon. Were we then to cultivate the turnip for its most natural products, the treatment it would require would much more nearly approach that adapted for wheat than at present; the deviations from it now observed, and which have been referred too exclusively to the *natural* specialities of the plants, would be greatly lessened, and the character of the plant as a "*fallow crop*" would be lost. It is no objection to this assumption that in selecting plants to transplant for seed *from which to grow bulb* those having the most symmetrical bulb are chosen rather than

such as are more fusiform, and betray a more abundant seed-forming habit—in this case it is not the most abundant natural seed that is the object of culture, but a seed having a special habit of growth, which habit it is wished to propagate.

There being an evident understood subserviency of the leaf of the turnip to the bulb, and a sort of succession in the order of maturation of these different organs, the latter not being perfected until the former has lost much of its succulence and vigour; this fact, and the special conformation of the plant, as before adverted to, have, in theory, led to an appreciation of forcing a large amount of leaf, which is not consistent either with the full efficiency of the conditions which our researches show to favour *bulb* formation, with the character of the soils best suited to the growth of the turnip-bulb, or that of the plant which is most approved by the practical agriculturist. It is true that relatively to wheat and many other plants, the turnip exhibits a large surface of succulent leaf, which, it is admitted, indicates a greater reliance in one way or other upon the atmosphere; yet all experience, when judging not between the turnip and other plants, but between one turnip and another turnip, values the one in which the proportion of leaf is least and the tendency to bulb the greatest. The description of soil which is called a turnip-soil, again, is just that which is best adapted to formation of fibrous root, and that which always yields a proportionally small amount of leaf. Moreover the soils which yield the largest amount of leaf are known not only by their general mechanical condition, but by their comparative richness in nitrogen, to be exactly those in which the results of our experiments would lead us to anticipate that the leaf-forming tendency would predominate. In these too, as compared with the lighter ones, an excess of nitrogen in the manure is the more likely to give an undesirable development, for in the latter any increased vigour of growth arising from nitrogenous agency may more easily extend the *underground* organs and determine to bulb-formation than in the former.

We have now given a history of our experiments upon turnip culture during the first three seasons of their course, so far as the conduct of them in the field is concerned, though none, as yet, of the results obtained in the two succeeding seasons, the last of which is now drawing to a close. Details of this kind having, however, already taken up much space, and sufficed, we hope, to elucidate some established rules of practice, we shall defer until a future occasion a further consideration of this branch of our evidence, and enter at once into an account of our researches in the laboratory, as tending not only to confirm or confute con-

clusions otherwise arrived at, but as opening out points of interest, both in science and in practice, not hitherto brought to view.

The atmosphere and the virgin soil being originally the exclusive sources, the former of the "*organic*," and the latter of the "*inorganic*" or "*mineral*" constituents of plants, it has been supposed that the amount of produce which a given space of ground would yield must depend upon its richness in those substances proper to itself, namely, the mineral constituents; and that these being supplied in full quantity, according to the indications of the analyses of the ashes of the crops it is wished to grow, the atmosphere would always prove an ample available resource for the more peculiarly vegetable matters. It will be readily understood that on such a view as this, economy in agriculture would be attained by a very different course of practice from that required were it to be shown that cultivation should effect an artificial accumulation in the soil of those constituents primarily derived from the atmosphere, rather than of such as more especially belong to its own constitution.

The theory referred to has led to the analysis of the ashes of a great many agricultural crops, and upon the data thus obtained (rather than upon a consideration of the requirements actually induced by an artificially enhanced vegetation, or of the real source and destination of the constituents under a course of practical agriculture), recommendations to the agriculturist have been founded, the validity of which it was desirable should be tested by actual experiment, as well as by the presumed dictates of experience. The field results which we have detailed, both upon the subjects of wheat and of turnips, are unfavourable to these opinions and recommendations, and analysis will be found to bear testimony in the same direction.

A knowledge of the composition of our crops, as affected by climate and cultivation, is however of great importance, not only as showing what are the sources which must be relied upon for the various constituents, but as assisting a judgment of the feeding value of the produce, and of the *economy* of the means to the adoption of which the variations in composition may be traced. It is more especially with a view to these points of interest that our results have been sought, and that their bearings will be now considered.

In the course of an analytical examination of an agricultural specimen, the first steps are to determine the per centages respectively of dry vegetable substance and of mineral matters. For this purpose a known weight of the produce is exposed for a length of time to such a temperature as will only expel all the water it contains; a portion is then burnt to an ash, which is presumed to retain all the "*mineral*," but none of the "*vegetable*,"

substances of the specimen, the latter having been consumed and vaporized by the burning process. The knowledge which these simple experiments may afford is never to be overlooked in considering the composition of an agricultural product, and estimating its probable value, or the economy of the manuring, or other means which have been employed in its growth. A judgment formed thus alone, however, of the comparative characters of different specimens would be fallacious, owing chiefly to the facts that the dry matter of different specimens of the same kind of plant may differ much in composition, and that a very large proportion of our agricultural produce is not allowed to ripen its seed and attain a somewhat fixed condition of dryness not materially affected by collection, storing, and transmission, but is taken whilst the vital circulation of the plant is still proceeding with considerable vigour, causing, long after removal from the land, a rapid exhalation of watery vapour, tending very much to mislead as to the amount of dry matter really contained in the substance under examination. Unless, then, a series of such specimens—the comparative characters of which are to be estimated—be treated in every respect similarly, as to time of gathering, weighing, &c., serious errors must occur.

When ultimate ripened products are the subjects of examination, there is little difficulty in conducting a series of drying experiments, so that the results shall be true indications of the differences really dependant on climate and culture; and although in such cases the range of variation in the amount of dry matter is small, yet the variations themselves are very significant, bespeaking at once the conditions of growth, and, within certain limits, the probable qualities of the products.

There can be little doubt that, after reliable standards have been fixed, a knowledge of the true undoubted per centage of dry matter in specimens of green produce also might materially aid our judgment of their other characters, but, as yet, neither have we these standards, nor are the methods of different experimenters so uniform that their results can compare one with another. So little, indeed, is really fixed and generally admitted regarding both the methods of and the proper inferences from such experiments, that the results of the same operator will, in his own view, be the more doubted the more he learns of the lesson they are calculated to teach; and before there can be any common argument or comparison conducted on such subjects, there must be some uniformity of method agreed upon. In illustration of this necessity one or two experiments only are needed.

A quantity of turnip-leaves were taken direct from the field to a barn about sunset, and were immediately weighed into lots of 25 and 50 oz. each. These bundles were laid upon straw, and

on re-weighing the following morning were found to have lost more than 6 per cent. If the leaves gathered in the evening had not been weighed for drying until the following morning, an error of 1 per cent. or more in the estimation of dry matter would thus have arisen. We have elsewhere stated that 100 oz. specimens of green wheat-plant lost invariably from 7 to 9 per cent. during the process of separating from each other the leaves, the ear, and the stem, although two persons were employed in the operation.

Again, five turnips, with their leaves, were found to weigh as soon as gathered 16 lbs. $4\frac{1}{2}$ oz.; after exposure two days and nights upon straw, under cover, they weighed 15 lbs. $5\frac{1}{2}$ oz.; and after three days and nights more, 14 lbs. $8\frac{1}{2}$ oz. Thus, if after being gathered 48 hours, 100 oz. had been taken for a drying experiment, it would have been equivalent to 106 oz. of fresh plant; and if after five days, to 112 oz. Five plants were next taken, and the leaves cut off, leaving, perhaps, two inches of stem upon the bulbs. The turnips, thus freed of their leaves, weighed 12 lbs. $8\frac{1}{2}$ oz.; after 48 hours on straw, under cover, 12 lbs. $4\frac{1}{2}$ oz.; and after 3 days more, 11 lbs. $3\frac{3}{4}$ oz. In this case, 100 oz. taken after being gathered 48 hours would have represented 102 oz. fresh bulb; and after 5 days, 106 oz. These turnip experiments were made in cold October weather; but the amount of loss sustained would of course depend much upon the vigour of growth of the plant, upon the state of the weather at the time, and the temperature of the place where the plants were kept.

It is evident, then, that very serious errors may arise when specimens are received from a distance, or even when they are not, unless special precautions be taken, according to the nature of the produce under examination. Indeed it is exceedingly difficult, when fully aware of these circumstances, so to conduct an extensive series of comparative experiments on green or succulent substances as to obtain results which shall be both actually and relatively to each other open to no objection.

When, in the experiments quoted above, bulbs with the leaves, or the leaves alone are taken, the loss is seen to be much greater than when the bulbs alone are operated upon. This is what might have been anticipated, and shows clearly that the effect is due to the continuance of the natural circulatory processes of the leaves after removal from the land.

In operating upon bulbs or roots which are in contact with the soil, we meet with a difficulty of another kind. In such cases there is always a quantity of soil adhering to the specimens, which, if not removed, will affect to some extent the determination of dry matter, and still more seriously that of the mineral matter. A single bulb may be cleaned sufficiently by careful picking and

wiping, but an extended series of determinations cannot be conducted under equal circumstances and with the necessary despatch without washing, by which soluble substances may to some extent be removed, or an absorption of water may take place. With the view of ascertaining the degree of error to which the washing of bulbs for drying and burning may lead, six lots, consisting each of five turnips, were taken, and the leaves were cut off, leaving a sufficient handle ; three of the lots were carefully cleaned without the use of water, the other three being scrubbed with a brush in water, in which they were allowed to remain for ten minutes or a quarter of an hour ; they were then taken out, rubbed dry with a cloth, sliced, and weighed. After exposure to a temperature of 212° for a sufficient time, the per centages of dry matter were as under :—

Lot.	Without washing.	With washing.
1	. . 8·36	7·96
2	. . 8·03	7·79
3	. . 7·64	7·30
	Average 8·01	7·68

There was evidently some difference in the specimens themselves, but the washing process gives in the main a less per centage of dry matter than the other. Without washing there must always be expected a small excess, and with it a slight deficiency. In the particular instances quoted the deficiency was likely to be greater than in the usual conduct of the process, as the operation was purposely rather prolonged, that the extreme effects might be ascertained. It is admitted, however, that washing is an objectionable procedure ; but when drying and burning experiments are conducted on an extended scale, the results will be more uniform in character and more comparable one with another than were any other method adopted, as all such either take up so much time that the specimens must, with the risk of change of weather, be collected at different times, or so many persons must be employed that the desirable surveillance is impracticable.

Having given thus far some general statement as to the manner in which our drying results have been obtained, those of our readers who understand such matters will be able to decide for what purposes our figures may be relied upon, and wherein they are likely to be wide of the exact truth. For ourselves, we are of opinion that, taken in series rather than individually, they may be trusted in discussing any points with which our general knowledge

of such subjects will lead us to deal, and that they very closely represent the exact facts.

The following dry-matter results refer only to the produce of the third year's experiments (season 1845). The entire series is tabulated.

Were we to consider each of these results *seriatim*, with a view to trace the variations in the produce to variations in the composition of the mineral or of the organic manures, we should find numerous exceptions to any generalization to which we might thus be led. When we look, however, at extreme instances, or at series strictly comparable one with another, we cannot fail to see some undoubted general connexion between the amount of dry matter on the one hand, and such character or stage of growth as we have already observed to result from certain conditions of manuring on the other. We must be careful, however, to bear in mind the nature of the substances on which we have been operating, and the various circumstances which have been pointed out as tending to vitiate the legitimacy of any comparisons; otherwise we may place undue reliance on single results, or, finding these discrepant with others, come to the conclusion that we have no lesson taught us by so extensive and laborious a course of experiments. With our present limited knowledge, it is, moreover, desirable to exercise great caution in applying to practice the indications of results of this kind.

It must be remembered, then, that the turnip plant cultivated as food for stock is gathered at no well-defined stage of its growth, but whilst containing a vast amount of circulating fluid, the proportion and concentration of which is subject to constant variation under the influence of the still active vital processes of the plant, the varying stores of moisture and of food presented to the roots, and the circumstances of temperature, light, and moisture of the atmosphere, to which the leaves are exposed. In fact, we might liken the growing turnip to an animal whose gross composition would vary according to his resources of food and drink, and the condition of exhaustion or waste to which he is exposed. At one time his stomach and blood-vessels are full, and at another their contents bear a much lessened relation to the more fixed portion of the body.

The water existing in the Norfolk white-turnip bulb is seen to constitute more than nine-tenths of its entire weight; and if it should appear that the proportion varies according to the stage of growth, it will be admitted that the degree of maturity of a succulent plant which is to be the subject of a drying experiment, must be regarded, in deciding its probable yield of solid food, as resulting from various manures; for if the amount of water is found to decrease accordingly as the plant matures, that one which

TABLE showing the Percentage of DRY MATTER in Specimens of Turnip Bulb, grown by various Manures. Season 1845.

Plot Numbers.	DESCRIPTION OF DRILLED MANURE.	Drilled Manures only.	Drilled Manures, and Top Dressing of Rape-cake.	Drilled Manures, and Top Dressing of Ammoniacal Salt.	Drilled Manures, and Top Dressing of Rape-cake and Ammoniacal Salt.
1	12 tons farm-yard dung, ridged in	7·83	7·92	7·30	8·86
2	Unmanured		8·68	8·71	8·29
3	8 cwt. rape-cake	7·80	7·38	7·77	7·92
4	130 lbs. calcined bone-dust, 130 lbs. sulphate of ammonia, 130 lbs. hydrochloric acid	8·20	7·66	7·71	7·55
5	160 lbs. superphosphate of lime, 130 lbs. sulphate of ammonia	8·77	7·95	7·64	7·73
6	160 lbs. superphosphate of lime, 5 cwt. train oil	8·41	8·26	7·92	7·50
7	12 cwt. sulphate of lime	8·56	8·00	8·05	8·00
8	400 lbs. calcined bone-dust	8·71	8·57	7·77	7·83
9	400 lbs. calcined bone-dust, hydrochloric acid equivalent to 268 lbs. of sulphuric acid (sp. gr. 1·70)	8·24	8·87	7·50	8·42
10	400 lbs. calcined bone-dust, 134 lbs. sulphuric acid	8·11	8·65	7·46	7·70
11	400 lbs. calcined bone-dust, 268 lbs. sulphuric acid	8·03	7·67	7·41	7·59
12	11 cwt. superphosphate of lime (land dug 9 inches deep in 1844)	8·71	8·19	7·29	7·61
13	400 lbs. calcined bone-dust, 268 lbs. sulphuric acid, 134 lbs. common salt	7·77	7·41	6·65	6·77
14	11 cwt. superphosphate of lime (land trenched 18 inches deep in 1844)	9·30	7·26	6·92	7·08
15	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 315 lbs. soda ash	8·23	7·14	7·41	7·33
16	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 220 lbs. magnesian limestone	8·69	7·61	8·20	7·22
17	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 470 lbs. pearlash	8·27	8·49	7·27	7·79
18	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 105 lbs. soda ash, 74 lbs. magnesian limestone, 157 lbs. pearlash	7·95	8·36	7·42	7·77
19	As No. 18, with 1 cwt. sulphate of ammonia	7·83	7·69	7·45	6·89
20	As No. 18, with 3 cwt. rape-cake	6·98	7·64	7·95	6·86
21	400 lbs. calcined bone-dust, 400 lbs. sulphuric acid	8·13	7·58	7·64	6·77
22	11 cwt. superphosphate of lime	8·24	7·83	7·36	7·38
	Mean results	8·22	7·95	7·60	7·58

after an equal period of growth is found to contain most water would conditionally indicate a more extended further growth, and the manure under which it had grown might be better rather than worse than that to which the more solid turnip owed its character. Again; a series of plots under different manures, though they will be characterized by an undoubted difference in the stage of maturity of the plant, will each within itself exhibit a wide range of variation in this respect, and it is impracticable to gather specimens which shall certainly and exactly represent the characters induced by the manuring of the plots. In our experiments, from ten to twenty plants of average size, and which appear to be sound and firm, are selected from each plot, and from these, when washed and sliced, a weighed quantity is taken; in some cases 100 oz., and in some 150 oz.; in some more and in some less. The results given in the table were obtained from specimen lots of 150 oz. each, and the soil, season, variety of turnip, and time of sowing and gathering, were the same throughout.*

From these remarks, our readers will be able to judge for themselves whether too much or too little is based upon our results. We feel, however, that it will be much more conducive to the interests of agriculture that the error should be in the latter rather than in the former direction.

The following mean results exhibit the general bearings of the experiments more clearly and safely than individual selections would do:—

Description of Drilled Manures.	Drilled Manures only.	Drilled Manures, and Top-dressing of Rape-cake.	Drilled Manures, and Top-dressing of Amm. Salt.	Drilled Manures, and Top-dressing of Rape-cake and Amm. Salt.
Mean of 13 purely mineral manures . .	8·34	7·97	7·41	7·48
Mean of 4 experiments with alkaline phosphates	8·28	7·90	7·57	7·53
Mean of 3 experiments with superphosphate of lime	8·09	7·97	7·50	7·35

These means show a striking uniformity in the amount of dry matter in each column taken separately,—that is, under the influence of various mineral manures, but a like resource for organic formations. Comparing column with column, however, we find a difference which, though not actually great, must be admitted to have some meaning, when we bear in mind the uniformity within the columns themselves. Were we to compare these effects of organic supply upon the percentage of dry matter with

* The conditions of manuring alone were different, and we may therefore rely upon the general indications of the experiments, so far as the effects of manures are concerned.

those of the same conditions upon the average acreage produce, no correspondence, either direct or inverse, would be clearly defined; for we see in the table just given a pretty uniform depreciation from the first column to the third, and the fourth is not wide of the third, but the acreage amounts of produce were as under:—

Average acreage produce of Bulb, in tons, cwts., qrs., and lbs.

Drilled Manures only.				Drilled Manures, and Top-dressing of Rape-cake.				Drilled Manures, and Top-dressing of Amm. Salt.				Drilled Manures, and Top-dressing of Rape-cake and Amm. Salt.			
Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.
12	8	2	3	13	4	2	20	11	18	1	24	11	6	1	11

We have before stated, that at the time of the first gathering of the crops, a short time prior to which the specimens for analysis were taken, the plants growing by purely mineral manures were very markedly the *ripest*, their leaves having much drooped; next in order, in this respect, came those having rape-cake in addition; then those having sulphate of ammonia; and, lastly, those with both rape-cape and ammoniacal salt. The proportion of leaf to bulb at the time of weighing shows this to some extent. It was as under:—

	Drilled Manures only.	Drilled Manures, and Top-dressing of Rape-cake.	Drilled Manures, and Top-dressing of Amm. Salt.	Drilled Manures, and Top-dressing of Rape-cake and Amm. Salt.
Proportion of leaf to 1000 of bulb . . .	326	421	559	669
Mean percentage of dry matter	8·34	7·97	7·41	7·48

We have, then, the largest amount of dry matter with the ripest bulb and poorest supply of organic manure, very nearly the smallest amount of dry matter with the plants least advanced to the points of heaviest bulb, but which had the largest stores of food in the soil, and probably the prospect of the longest life and fullest eventual growth, at least of entire plant, if not of bulb itself. The second weighing of the crops did indeed show in this case an increase in bulb and a decline in the proportion of leaf to bulb. Here, then, the influence of manures is indirect; for the proportion of dry matter is seen to be mainly dependent upon the degree of maturity of the plant,—and that this is affected by manures has been already shown; and since the largest proportion of dry matter may show an early advanced stage of maturity, frequently arising from an exhaustion of the materials

of growth, it may in fact bespeak the worst manuring condition, all other circumstances being equal. It is evident then, that, even supposing the percentage of dry matter to be an unconditional measure of the feeding value of any particular specimens, no comparison could be drawn respecting the efficiency of the manures by which they were grown, unless every other condition, whether of season, soil, maturity or variety, were considered in their influence; and then, indeed, the effects of the manures may be due to a forcing rather than to a supporting power. We shall have further proof, however, that the amount of water existing in the turnip depends upon the proportion of circulatory to the more fixed matter, and that as the plant matures that of the former diminishes and that of the latter increases; and it will also be seen that equal weights of dry matter may differ very greatly in probable nutritive value.

Before leaving the results of the table, we may observe that by this series of nearly 100 different manures, the utmost variation in the proportion of dry matter in the Norfolk white-turnip bulb is, after an equal period of time, 2·65, or about 2½ per cent., notwithstanding that there was a vast difference in the stage of maturity of the plants; and it is thought that if the specimens could have been taken each at the point of its fullest growth, the variation strictly dependent on manures would have been much less. The highest percentage of dry matter in the entire series is 9·3,—all the rest are below 9, more than half below 8, and several below 7; the limit of difference, even under the actual circumstances, is, however, in by far the larger number of cases within 1 per cent. Boussingault gives 7·58 per cent., which agrees pretty well with our determinations, the mean of which is 7·83; other observers having found a range in the proportion of dry matter of the turnip-bulb from this amount to nearly double, have attributed much of the variation to the conditions of manuring; but the foregoing facts, in conjunction with those we shall now state, will show that no judgment of the effects of manures in this respect can be formed unless the experiments are made with the same variety of the plant.

The specimens here referred to were grown in different fields, and by different manures, and several of them in the ordinary course of the farm. The 90 lots of experimental Norfolk whites give a number for the mean percentage of dry matter identical with that found under farm-yard dung, and their extreme variation is 2·65. The two specimens of green common turnips show the same amount of dry matter with a difference of manuring. The various swedes again differ considerably from one another, yet in a greater degree from the common turnips. The extreme variation in the entire series quoted is from 6·65 in the Norfolk

Description of Turnips.	Percentage of Dry Matter in Turnip Bulbs.
Norfolk White (lowest of experimental series)	6·65
,, ,, (highest of experimental series)	9·30
,, ,, (mean of experimental series)	7·83
,, ,, by farm-yard dung in experimental series	7·83
Green common turnip, by farm-yard dung	7·94
,, ,, by superphosphate of lime	7·94
Swede, Skirving's green top	9·04
,, ,, purple top	9·61
,, purple top (old variety, name unknown)	12·25

whites to 12·25 in the purple-topped swede, or more than 5½ per cent.; but there is little doubt that it is dependent on the variety of plant, rather than upon any effects of manure or culture.

As a general inference from our results, we may state that the mineral and carbonaceous manures, which we have before seen to favour bulb-formation,—that is, to determine to an early maturity, are those which in a given time will yield the largest percentage of dry matter in the bulb; but nitrogenous manures, on the other hand, which when in excess do not enhance bulb-formation (a process of deposition), but rather an extension of the leaf or more vascular system of the plant, involving a prolonged tendency to active circulation, and consequently a higher amount of vehicular watery fluid in proportion to fixed substance, will afford a smaller percentage of dry matter in the produced bulb.

Were we, assuming bulb-formation to succeed leaf-formation, to judge from some analogy furnished by other plants, we might expect that the earlier organ, the leaf, would contain a less per centage of dry matter than the later one, the bulb; but inasmuch as the dry matter is frequently about twice as great in the former as in the latter, any such reasoning would imply a wrong conception of the physiological relationship of the two organs.

We regret that the entire series of leaves of this 3rd year of our experiments was not collected for drying, and that indeed none were taken until after the first weighing of the crops, a few weeks later than the specimen-bulbs were gathered. We shall not, therefore, employ the results for any more important purpose than to show how far the effects of manures are the same in kind as in the case of the bulbs, determining to the *depositing* or to the more *circulatory* tendencies of growth.

Here again we find no considerable variation, yet sufficient in amount and in uniformity to render the mean results reliable for our present purpose. The plants by mineral manures alone, in the first column, which were the furthest advanced in maturation

PERCENTAGE of Dry Matter in Norfolk White Turnip Leaf.

Plot Numbers.	Description of Drilled Manures.	Drilled Manures only.	Drilled Manures, and Top-dressing of Sulph. Am.	Drilled Manures, and Top-dressing of Rape-cake and Sulph. Ammonia.
9	400 lbs. calcined bone-dust, hydrochloric acid = 268 lbs. sulphuric acid	13·63	13·23	12·57
14	11 cwt. superphosphate of lime (land trenched 18 inches deep in 1844)	13·93	13·19	12·74
18	400 lbs. calcined bone-dust, 420 lbs. sulphuric acid, 105 lbs. soda ash, 74 lbs. magnesian limestone, and 157 lbs. pearlash	13·79	13·48	13·46
21	400 lbs. calcined bone-dust, and 400 lbs. sulphuric acid	13·33	13·12	12·68
22	11 cwt. superphosphate of lime	13·97	13·55	12·91
	Mean results	13·73	13·31	12·87

(or almost past that point), give the highest percentage of dry matter in the leaf as well as in the bulb. Those under the addition of ammoniacal salt give in the leaf a percentage uniformly, but not so far relatively lower as in the case of the bulbs; but it must be remembered that the leaves were gathered much later, and indeed, when, in these cases as well as in those by the purely mineral manures, the point of maturity and exhaustion of soil-supplies for organic food had been approached or past. We find again that the more vigorous plants under both rape-cake and ammoniacal salt have, coincidently with the greater prevalence of vascular action, a less percentage of dry matter.

Whilst we are writing, the specimens of the present season's growth are being operated upon in the drying bath, but as we have not given any account of our experiments since 1845, we need only say that succeeding results indicate the same general facts on the subject of dry matter as those to which we have drawn attention.

Having argued that, supposing the dry matter in the turnip were of uniform composition, a high percentage can only indicate the amount of solid substance in a given amount of produce at the period of growth at which the determination is made, and does not by any means unconditionally show the efficiency of the manures employed, we shall turn our attention to the composition of the dry substance itself. It has been stated that dry vegetable produce contains the so-called *vegetable* or "*organic*" constituents, and the "*mineral*" or "*inorganic,*" the latter being that portion which remains after the former is burnt away.

We shall first speak of the composition of the organic or vegetable part of the turnip, and shall endeavour to show its dependence on the manures by which the plant is grown, and the probable relative feeding values of different specimens.

We do not pretend to have reached further than the threshold of this inquiry, but still hope our results may furnish some interesting inferences. The organic matter of the turnip-bulb is composed of several complex bodies, some of which consist chiefly of carbon, hydrogen, and oxygen, whilst others contain nitrogen in addition to the other three elements. Other substances, such as sulphur and phosphorus, are also found in these compounds, but in small quantities, and their presence or absence is immaterial to us just now.

Those of the compounds which contain nitrogen are in less proportion in plants than those in which it is absent; but nitrogen is a very important constituent in all food, so much so indeed that the comparative feeding value of different articles of produce may frequently be estimated by the amount of nitrogen they contain; and we shall, to some extent, act upon this assumption in what we are about to detail.

Those who have read the paper on Agricultural Chemistry in the last Number of this Journal, will bear in mind the remarkable fact there indicated, that the larger the amount of the nitrogen supplied by manure for the growth of wheat, the less was the percentage of that substance in the produced grain. This is not consistent with the views generally maintained on this subject, but it seemed to us not only sufficiently proved by our experiments—but, when it was remembered that wheat-grain was peculiarly a *starchy* seed, and that starch contains no nitrogen, it was thought that whatever tended to the healthy action of the plant (as nitrogenous manures were found to do) would of necessity develop the special aim and products of the plant, and that in fact it was more natural to expect that the seed would under these circumstances be more *starchy* than that it would be more nitrogenous and less starchy. In growing *wheat-grain*, then, by means of *nitrogenous* manures the *percentage* of nitrogen in the produce was rather diminished than increased. The following results will show whether a similar effect is observed in the growth of turnip-bulbs:—

This is not the place to give any detailed account of our methods of analysis, but we may say that we think considerable confidence may be placed in the results, as a comparative series; and we believe them to be, moreover, not wide of the exact truth. If we had to give an opinion, however, as to the probable direction and extent of any error, we should suspect it to be in defect rather than in excess, and that if it exist it is pretty uniform throughout

PERCENTAGES of Nitrogen in Dry Turnip Bulbs, the produce of different Manures.

Plot Numbers.	Description of Drilled Manures.	Drilled Manures only.	Drilled Manures, and Top-dressing of Rape-cake.	Drilled Manures, and Top-dressing of Amm. Salt.	Drilled Manures, and Top-dressing of Rape-cake and Amm. Salt.
9	400 lbs. calcined bone-dust, hydrochloric acid = 268 lbs. sulphuric acid	1·46	1·93	2·82	2·22
22	11 cwt. superphosphate of lime . .	1·58	1·89	2·89	2·44
	Mean Results	1·52	1·91	2·86	2·33

the series; that its probable extent is 0·10, and its utmost range 0·20. Should such general deficiency pervade our results, it is dependent partly on the fact that succulent specimens cannot be fully dried in air at 212° without some loss of nitrogen, and in part also upon certain practical difficulties attending the conduct of the determination of nitrogen in substances in which the actual percentage is so small as in the instances before us. We may add that each of the results given in this paper is the mean of two determinations at least, and when there has been a difference of 0·10 a third has always been made.

Referring to the results of the table, and taking the columns separately, we see a very marked coincidence between the figures in each, and as marked a contrast between column and column; and if we call to mind the peculiarities of the several organic conditions of manuring, we shall see the influence of the nitrogenous supply to be exactly opposite to that observed in the case of wheat-grain, and in fact that the per centage of nitrogen in the turnip-bulb bears a direct instead of an inverse relation to the predominance of that substance in the manure.

Thus in the instances quoted the percentage of nitrogen in the dry substance of the produced bulb is by mineral manures alone 1·52; by the addition of rape-cake, which contains, besides a large amount of carbon, a considerable quantity of nitrogen, we have 1·91 per cent.; by ammoniacal salts, supplying abundance of nitrogen, but no carbon, 2·86 per cent.; and when to this exclusive nitrogenous supply rape-cake is superadded, we have 2·33 per cent. There is here seen, then, very evident connexion between the percentage of nitrogen in the substance of the bulb, and the supply of it in the manures employed. It is worthy of remark, however, that it is not the actual acreage quantity of nitrogen, but its proportion to other constituents that is so clearly indicated. Thus in the third column, with an acreage supply of

about 60 lbs. of nitrogen by manure, we have a percentage of 2·86 in the dry matter of the produced bulb, whilst in the fourth column, with a supply of about 110 lbs. per acre, we have only 2·33 per cent.; but when we remember that in the latter case there was a large amount of carbon in the manure, and in the former none, we have a clear illustration of the close connexion between the provision by manure and the composition of the produce. To render our meaning more intelligible we may further explain that the nitrogen in the turnip, and indeed in food-products generally, exists in combination with carbon, hydrogen, and oxygen, itself comprising nearly one-sixth part of the thus constituted nitrogenous compound; the remainder of the dry matter consists of the compounds destitute of nitrogen, of which the chief constituent is carbon. Now in column 3 there was no carbon in the manure, but in column 4 a large amount was provided in the rape-cake, and notwithstanding that there was in this case not only the same amount of nitrogen supplied by ammonia salt as in column 3, but further, all that of the rape-cake, raising the total amount to nearly double, yet the supply at the same time of carbon favouring the formation of non-nitrogenous compounds, gives a less proportion of those which are nitrogenous.

Again, if we compare the mean of these results with the mean percentage of dry matter under the four conditions of manuring, we find with the lowest per centage of nitrogen in the bulb the largest amount of dry matter, and with the highest percentage of nitrogen the lowest amount of dry matter. There is then with the highest percentage of nitrogen more of circulating fluid and less of fixed deposited substance than with the lowest; and since there was moreover not only a less matured bulb, but a less acreage produce of it in a given time than where the nitrogenous supply was less, we are led to infer that the high percentage of nitrogen indicates a relative deficiency of carbonaceous substance, rather than a favourably increased amount of nitrogen. Indeed these results will confirm the opinion already urged, namely, that turnip-bulb formation is very dependent on an abundant supply of *carbonaceous matter to the roots,* and that the more the nitrogenous condition of manuring prevails over the carbonaceous, the more will vascularity and the less will special deposition be enhanced. Thus the highly vascular seed-forming turnip-plant is to the less vascular bulb-forming one, as the well-conditioned breeding or working animal is to the stall-fed fatting one; a considerable amount of nitrogenous as well as carbonaceous food is essential to both of these; in the one case, however, exercise tends to consume what in the other increases the bulk of the animal: so that whilst the food taken may indeed in the two cases be very similar, yet the balance of it retained in

the animal will be as different as, in the cases of the two plants, is attained by more directly varying the supply, and the peculiar habits of life and growth will be developed accordingly.

The following results further show how truly dependent is the composition of the turnip-bulb upon the provision by manure:—

PERCENTAGES of Nitrogen in the Dry Matter of Turnip Bulbs, the produce of different Manures.

Plot Numbers.	Conditions of Standard Manuring.	Standard Manures only.	Standard Manures, and Top-dressing of Rape-cake.	Standard Manures, and Top-dressing of Amm. Salt.	Standard Manures, and Top-dressing of Rape-cake and Amm. Salt.
1	12 tons farm-yard dung	1·56	..	2·54	..
2	Unmanured	3·31	2·17	2·98	2·53
3	8 cwts. rape-cake	2·23	2·79	2·80	3·00

We see that the percentage of nitrogen by farm-yard dung is 1·56, which differs little from either the results obtained by mineral manures alone, when all the organic supply was derived from normal sources, or from the number observed by Boussingault, which was 1·70. The addition of sulphate of ammonia to the farm-yard dung, raises the percentage of nitrogen in the bulb from 1·56 to 2·54, or by two-thirds of the usually observed amount. Here, however, we have in the manure a large provision of carbonaceous matter, and, as before noticed, a coincidently less percentage of nitrogen than when there was ammoniacal salt alone.

In the second line of the table we have some most interesting results, consistent with what have gone before, and, further, affording a new and significant illustration of the office of the turnip as a *fallow-crop.*

It will be recollected that the average weight of the bulbs on the unmanured plot was in this season of 1845 less than 2 oz., and that the entire produce was only 13½ cwts. per acre. We find, however, that these stunted bulbs give a percentage of nitrogen higher than any in our series, even than those which had an unusually excessive supply by manure, and twice as high as the amount supposed generally to exist in the cultivated bulb. We may reasonably infer that, under the influence of season and a soil reduced to the lowest conceivable state of exhaustion, as regards its fitness for the growth of the cultivated turnip, the natural supply of nitrogen was, in proportion to that of other constituents, abundantly available to the special accumulative powers of the plant. In the same line we find, in the second column,

that the supply of a top-dressing of rape-cake to this otherwise exhausted plot, raises the acreage produce of bulb from $13\frac{1}{2}$ cwts. to $7\frac{1}{2}$ tons, and the average weight of bulb from less than 2 to nearly 11 oz., and notwithstanding the nitrogenous supply of the rape-cake, we have, with its large provision of carbonaceous substance, the percentage of nitrogen reduced from 3·31 to 2·17. In the 3rd column, where there is added to the natural supplies of soil and season nitrogen, but *no* carbon, we had an evidently unhealthy condition; for the acreage produce, the size of bulb, and the number of plants, were all less than where there was no manure whatever. Again, with these unfavourable circumstances of growth we have a very large percentage of nitrogen; less, indeed, than in the unmanured bulbs, but considerably higher than when rape-cake alone was used. In the 4th column we have the same supply by manure of carbon and nitrogen as in column 2, with the addition, however, of the nitrogen as in column 3, and we find, as in other cases, that although the actual supply of nitrogen is greater than in column 3, it being proportionably less, the percentage in the bulb is reduced.

In the third line the standard manure is rape-cake, the extra dressings being, as usual, a further addition of rape-cake, of ammoniacal salt, or of both. Comparing the percentage of nitrogen by the drilled rape-cake, as in column 1, with that by farm-yard dung, we find that the rape-cake gives the highest, and we would suppose the proportion of nitrogen to carbon would be greater. In column 2 the amount of rape-cake being greater, the percentage of nitrogen is greater: the *supply* of nitrogen to that of carbon is not, however, greater than in column 1; but we have before seen that a full quantity of rape-cake, without extra mineral manure, is not conducive to the most healthy growth of the turnip-bulb; nor indeed would the carbon so supplied be so completely and rapidly available as the nitrogen. The addition of ammoniacal salt in column 3 raises the percentage of nitrogen from 2·23 to 2·80, and in column 4, as compared with column 2, from 2·79 to 3·00.

We have made other determinations of nitrogen in turnip-bulb, with a view to some more special points, but as we cannot discuss them in this paper without extending our remarks to an undue length, we shall defer notice of them until a future occasion. The results already given are moreover, we think, sufficient to aid our estimation of the characters of the turnip as a food and rotation crop.

An important fact elicited is, that within a certain range, which indeed is wider than has generally been supposed, the organic composition of the turnip bears a very direct relation to that of the manures by which it is grown. It is seen that the proportion

of nitrogen usually found in the cultivated turnip-bulb may be nearly doubled by means of ammoniacal manures, and since we have stated that the feeding value of a crop may to some extent be measured by its percentage of nitrogen, it might be supposed that we should be led strongly to advocate the use of such manures in the growth of the turnip. Our field experiments have already shown, however, that this would be a one-sided inference from these departmental results; and when we come to make some general application of our varied evidence to practical and economic agriculture, the true position and bearing of the different branches of the question will be indicated.

We regret that we have not as yet a sufficient number of determinations of nitrogen in the turnip leaf to enable us to decide satisfactorily whether the percentage be as clearly dependent upon the supply by manure as in the case of the bulb; the vigorous leaf being, however, highly vascular, and containing much of the still circulating unassimilated food derived from the soil, we might anticipate it would be so; but, on the other hand, if we look at the bulb as a reservoir of matters which are in excess so far as the natural seed-forming tendencies are concerned, we might expect the less artificial organs, the leaves, would be more constant in their composition. The following results will not assist us much in deciding these questions; they are, however, not without interest:—

Percentage of Nitrogen in the Dry Matter of Norfolk White Turnip Leaf.

Plot Numbers.	Description of Manures.	Dried at 212°.	Specimen dried below 200°, and Nitrogen calculated upon fully dried Substance.
1	Farm-yard dung . .	3·24	3·60
2	Unmanured . . .	4·22	4·35

Here are given the results obtained from specimens of leaf, in one instance dried fully at 212° in the water bath, and in another dried much below that temperature; the percentage of nitrogen in this case being calculated upon the fully desiccated substance. The fact before alluded to, that succulent specimens frequently lose nitrogen at 212°, is thus illustrated; in one instance there is a defect of 0·36, and in the other of 0·13. We have met with a similar result with other succulent substances.

It will be remembered that the turnip-leaf was found to contain a proportion of dry matter more than half as large again as the bulb; and it is seen that in the case of the dung specimen the dry

matter of the leaf has a percentage of nitrogen twice as high as that of the bulb. A given weight of the fresh leaf would therefore contain more than three times as much nitrogen as an equal amount of bulb. Since, however, the bulk of the leaves at the time the turnip crop is gathered or consumed are past the condition in which our picked specimens were taken for analysis, it would be unsafe to employ these results for purposes of acreage calculation; yet they are in other respects to be relied upon.

Comparing the characters of the cultivated with those of the uncultivated plants, as shown by the analyses which have been given, we observe the decrease by cultivation in the percentage of nitrogen in the dry matter is in the leaf only ·75, but in the bulb 1·75; from which, again, we may perhaps gather that the cultivated bulb is the result of a continued accumulation of *secreted* matters, formed in quantity beyond the essential requirements of the plant as such: the leaf, on the other hand, containing, besides its own special structures and products, little more than those substances derived from *immediate* supply,—has, therefore, a composition in a less degree varying according to the constant circumstances of growth, but comprising a larger proportion of unsecreted matter.

The fact that, notwithstanding the large nitrogenous contents of turnip-leaves, they should only be to a small extent valued as food, doubtless arises from the large amount of matters which they contain only brought within the range of the organism, themselves as yet unorganised, and existing as saline and other changeable fluids, to which we may readily attribute a medicinal and purgative, rather than a direct nutritive effect; elaboration to some extent being, as we are aware, an important element in the condition of food for animals. The low degree of stability in some of the nitrogenous contents of succulent substances, as indicated in the drying process, as well as our conceptions of the offices and physiological position of the different parts of a plant, bespeak, indeed, that where an active circulation is still proceeding, there will be found not only the actual and fixed, but also the prospectively possible constituents, the latter as yet only in a vehicular condition, and little influenced by the selective and appropriative powers of the organism. It is true that the varying character of the vital apparatus of different animals adapts them to the use of vegetable food in varying degrees and states of elaboration; but there seems to be a point in this degree of elaboration below which constituents lose their food-qualities; or even, it may be doubted whether, in such cases, the matters are not really as little truly vegetable as would be the watery extract of the soil as it is taken up by the rootlets, and from the condition of which little deviation has hitherto resulted from the vital actions of the plant.

Such substances, indeed, may perhaps be considered as still belonging to the mineral kingdom, upon which animal life cannot be sustained.

Referring to the more special lesson of the experimental results last given, we notice, that whilst the leaf grown by farm-yard dung contains 3·60 per cent. of nitrogen in its dry matter, that grown without manure of any kind in a turnip-bulb exhausted soil has 4·35 per cent; and it will be remembered, the bulbs corresponding to these specimens of leaf give respectively 1·56 and 3·31 per cent. We have, then, in the leaf as well as in the bulb, a larger proportion of nitrogen in the more natural but agriculturally useless turnip than in the cultivated one; and if we are right in considering that, within certain limits, the composition of a succulent imperfectly elaborated vegetable will bear some direct relation to the supplies of food within its reach, we must conceive that there was, independently of art, a resource of nitrogen available to the uncultivated plants far beyond that of other necessary constituents. If, then, the powers of reliance upon normal supplies of nitrogen here observed are to be fully developed and turned to economical account, it is more especially by means of an artificial provision of the other constituents that this object will be attained.

We think that in these facts we have a beautiful illustration of some of the physical and physiological characters upon which depend, materially at least, the economic value of the turnip in rotation with corn. The true *economy* of alternate cropping, whilst, however, it is intimately associated with functional differences, such as we have shown to exist in the selected plants, yet depends much also upon the destination and uses of the produce, independently of which, the peculiar accumulative tendencies of the different crops could not be rendered profitably subservient. We shall not, however, consider the connexion between the various sources of the economy of a rotation of crops, until, having detailed all the evidence which it is our intention to bring forward, we come to sum up and apply our departmental results to the practice of agriculture.

We shall now give some account of the mineral substances found in the turnip. Our experimental results referring to this branch of the question are very numerous, and it was our wish to have considered them somewhat fully; but as our permitted space is already nearly exhausted, we must defer doing so until a future opportunity, and confine our remarks on this occasion to some explanation of the nature of the subject, and to indicating the general bearing of our evidence upon the conclusions which have been arrived at in the foregoing pages.

The knowledge which we at present possess of the amount, the composition, and the office of the mineral matter found in combination with the various definite organic compounds of which the solid and fixed substance of a plant is made up, is very limited; yet ıis such as by no means leads us to assign to all the constituents of the ash of a crude vegetable product an essential position in the constitution either of the parts already elaborated, or of those which would result from the continued growth of the plant. It is obvious that an examination into the nature and constancy of the circumstances of growth, with which variations in the quantity and composition of plant-ashes are connected, cannot alone provide an explanation of the uses and importance of the mineral substances in the plant; it is, however, an essential step in the inquiry, and the results attained by it must materially direct and aid any collateral course of investigation.

In entering at once upon this part of our evidence, we may again state that we did not determine the amount of dry matter in the produce of the first two seasons' experiments: we are unable, therefore, to give the percentage of ash in the dry matter in the specimens of those two seasons, and it will afterwards be seen that this particular is more significant than that of the percentage in the fresh produce. On this account, and as we wish to compress our matter as much as possible, we shall not give any statement of the results of those two years, but only remark that a close examination of them affords like conclusions to those to which the third season's experiments lead us.

The percentage of ash in the fresh bulbs, the mean of the produce of each of the four conditions of manuring, frequently referred to before, are given below.

General Description of Manuring.		Percentage of Ash in Fresh Substance of "Norfolk White" Turnip Bulb.
Season 1845.	Mean of 13 experiments by purely mineral manures . .	0·58
Season 1845.	Mean of 13 experiments by mineral manures and rape-cake added.	0·57
Season 1845.	Mean of 13 experiments by mineral manures and ammoniacal salt	0·61
Season 1845.	Mean of 13 experiments by mineral manures, and both ammoniacal salt and rape cake	0·60

These results are the actually found percentages of ash, without any deduction for adventitious substances, such as siliceous matter and charcoal. The figures exhibit very slight differences, such as could not justify any important conclusions, were these

contrary to otherwise probable indications; we find however, that, slight as the differences are, they are such in kind as other circumstances would lead us to anticipate; and we need only notice that the percentage of ash is seen to be highest where the nitrogenous condition of manuring was predominant, and lowest where the carbonaceous was more characteristic.

The variations are, however, more apparent when the per centages of ash upon the dry, rather than upon the fresh, matter are are given. The mean percentage of the dry matter itself, and of its ash, in the specimens last quoted, and of the nitrogen in the dry matter of two of the specimens in each case, are here tabulated:—

General Description of Manuring.	Percentage of Dry Matter in Bulb.	Percentage of Ash in Dry Matter.	Percentage of Nitrogen in Dry Matter (Specimens Nos. 9 and 22).
1845. Mean of 13 experiments by purely mineral manures	8·34	6·99	1·52
1845. Mean of 13 experiments by mineral manures and rape-cake	7·97	7·21	1·91
1845. Mean of 13 experiments by mineral manures and ammoniacal salt	7·41	8·24	2·86
1845. Mean of 13 experiments by mineral manures and ammoniacal salt and rape-cake	7·48	8·08	2·33

The coincidences here brought to view are of considerable interest, and clearly show a constant decrease in amount of mineral matter as the deposition of solid vegetable substance progresses. We have with the highest proportion of dry, the lowest proportion of mineral matter; and with the lowest amount of dry matter, the highest of mineral substances; and even with the slight increase in dry matter exhibited in line 4, compared with line 3, we have a decrease in the percentage of mineral constituents. We can scarcely fail to recognise in these results a marked distinction between those constituents of the bulb which are as yet merely circulatory and unappropriated, and those which are secreted and fixed, the former being indicated by a small amount of dry matter and large amount of ash, and the latter by a large amount of dry matter and a small amount of ash.

The connexion between the amount of dry matter and its percentage of ash being admitted, and that between the amount of nitrogen, that of dry matter, and the condition of maturation having been pointed out before, it is seen that the views taken are fully confirmed by the relation of the ash in the dry matter to that of the nitrogen in the same. Thus we have in the Table, with the most fixed matter and least nitrogen, also the least ash;

and with the most ash and most nitrogen, the least dry matter. The relative tendency to bulbous deposition, or active vascular circulation, under carbonaceous and nitrogenous manures respectively, is here again exhibited.

It will be remembered that the specimens of turnip-leaf which were examined, were gathered very late in the season—the few that could be selected green being taken. All were, however, far advanced in stage of growth, and it was found that, whether owing to an uniformity in the stage of growth, or to the essential tendency of the leaves, as different from that of the bulb, there was very little variation in the proportion of dry matter, compared with that observed in the bulbs. The following mean results will illustrate this:—

Reference to History of the Specimens.	Percentage of Dry Matter in Leaf.	Percentage of Ash in Fresh Leaf.	Percentage of Ash in Dry Matter.
Mean of 9, 14, 18, 21, and 22, with mineral manures only	13·73	1·31	9·52
Mean of 9, 14, 18, 21, and 22, with mineral manures and ammoniacal salt	13·31	1·26	9·49
Mean of 9, 14, 18, 21, and 22, with mineral manures, rape-cake, and ammoniacal salt	12·87	1·25	9·72

The differences here seen are, as we have already implied, small; nor are the results so undoubted in their bearing as most that have been quoted; yet still we have with the smallest amount of dry matter, the largest per centage of ash in the dry matter. The centre column shows the lowest percentage of ash in the *fresh* leaf in this case; but it is of course the percentage to *water*, rather than to dry vegetable substance, that is there indicated.

The comparative ash results that have been given, whether of the turnip-bulb or leaf, lead us then yet again to draw some distinctions between the fixed and the circulating constituents of a succulent plant, and to trace the proportion of these respectively to the stage of maturity of the organ, whilst this has been found to depend greatly upon the supply by manure.

Were we to compare the composition of the leaf, as thus far shown, with that of the bulb, and to attempt to apply on all points the same kind of reasoning as between bulb and bulb, or leaf and leaf, we should at once meet with inconsistencies, for we find in the earlier product of the plant—the leaf—a much larger amount of dry matter than in the later one—the bulb. And again, with the higher percentage of dry matter in the leaf, we have at the same time a much larger amount of ash in that dry matter. Such comparisons are, however, physiologically, quite inadmissible. Looking at the question in another view, however, we have attri-

buted to the bulb, notwithstanding its large amount of water, in some respects a higher condition of elaboration, or fixedness in its solid constituents, than to the leaf. We have, indeed, supposed that bulb formation, in the degree in which it is developed for feeding purposes, is a deposition of matter existing in quantity beyond what is *essential* to the health of the natural plant, much as depositions are known to take place in animals under somewhat analogous circumstances.

The following comparative statement of the proportion of ash in the dry matter of the leaf, the bulb, and the seed of the Norfolk white turnip, will favour the view that the composition of the bulb implies a more advanced selective process than that of leaf:—

	Leaf.	Bulb.	Seed.
Percentage of ash in the dry matter of	9·5	6·9	4·5

There is then, comparing one organ with another, as well as different specimens of the same organ, a diminution in the proportion of the mineral to the organic constituents of the plant the further we advance towards the matured results of the vital process. It is true that even in the seed the amount of mineral substances is greater than our conceptions regarding the composition of the definite compounds of which it is made up would alone have led us to anticipate; but numerous experiments with wheat grain show that, however small may be the differences exhibited in a series of specimens which can be compared with each other in this respect, yet they will indicate the less percentage of ash in the dry matter the higher the percentage of the dry matter itself—that is to say, the more completely ripening processes have been developed. An *excess* of mineral matter in any such case may to some extent therefore be owing to an increased proportion of vascular contents to perfectly elaborated substance.

Admitting that the mineral substances found in the leaves of the turnip and of other plants are such in variety and in amount that we cannot suppose them to be all destined to enter into combination, and actually to constitute a portion of the fixed and essential formations of the plants, yet their presence within it is not on that account quite inexplicable. The experiments of De Saussure and others show that the rootlets of a plant take up the dissolved substances presented to them, exercising but little of selective power, whilst such as they have is rather of a mechanical than of a more purely vital kind. It is not to be wondered at, then, that the composition of the ash of highly vascular vegetable substances should exhibit a wide range of difference, according to climate, manuring, and soil. In such cases a large proportion of

the mineral matters are distributed, not as constituents of the organized substance of the plant, but in its vessels and fluids, owing their quantity and character, to a great extent, to the external influences just referred to, but little, comparatively, to the selective processes of the organism.

The following mean results of analysis seem to show that the more the truly vital processes have been exercised, the more *special* does the composition of the mineral matter become:—

	Leaf Ash.	Bulb Ash.
	Mean of 24 Analyses by Mr. D. Campbell.	Mean of 24 Analyses by Dr. Gilbert.
Potass	22·05	44·84
Chloride of potassium. .	4·84	0·34
Soda	0·19	1·79
Chloride of sodium . .	6·15	6·86
Lime	30·53	11·40
Magnesia	0·82	1·46
Phosphoric acid* . . .	5·05	7·89
Sulphuric acid . . .	12·55	10·63
Carbonic acid	17·82	14·79
	100·00	100·00

These results being the mean of so many analyses as twenty-four in each case, the general character of the distinctions they exhibit may be fully relied upon. It is to be regretted that we have not an actual analysis of the ash of the seed of the Norfolk white, to place by the side of those of the leaf and of the bulb. We know, however, that phosphoric acid, potass, and magnesia are eminently seed-ash constituents, and that the existence of the vehicular element, chlorine, in a *perfectly ripened* seed is doubtful. The increase in the percentage of the more special, and decrease in that of the less special constituents, is clearly shown in the results given above, as we proceed from the earlier formation to the later one, the composition of which is more influenced by the peculiar elaborative action of the organism. Of the soda salts, indeed, the actual amount is somewhat larger in the bulb than in the leaf, but their proportion to the potass ones is much less.

It has been observed that the ash analyses of green crops seem to afford confirmation of the much discussed theory of the substitution of potass by soda in plants, but that those of grain crops, on the other hand, do not serve the same purpose. It seems to us, however, that if in green and succulent substances, in which

* In the analysis of the leaf and bulb ash, the phosphoric acid is calculated from the bone-earth precipitate, taking no account of the small quantity of iron salt usually present.

there exists a considerable amount of matter admitted by the roots, with but little of special selective power, the proportions of potass and soda may vary according to the variations in the soluble contents of the soil, but the further we advance towards the ultimate results of the organism, the larger is the proportion of potass to soda; there is in such a fact evidence against the supposition that the vegetable organism can substitute the one alkali for the other, for in the case assumed soda would seem to be present only *before* the *vital* selective processes had been exercised upon the matters brought within their sphere of influence. If, then, the theory referred to suppose a replacement of potass by soda, as an actual constituent of vegetable products, we think that facts hitherto observed are such as should tend to disprove rather than to prove its validity. On the other hand, we may well believe that the large amount of mineral matters admitted into a plant, beyond that which is likely to become fixed and combined with its structures or deposits, has, nevertheless, some office to perform. We know too little, however, of the means employed by the vital processes to enable us to assign special agencies to special substances; yet the presence of mineral matters not actually to take part as constituents, is by no means improbably of essential importance in determining the changes to which the circulating juices of the plant are subject; nor is it impossible that in such an office as this soda may substitute potass, and one acid another, that is to say, as *agents*, if not as constituents. It is, indeed, only by supposing some other requirement in the plant than that of mere provision of actual constituents, that we can in any degree account either for the extraordinary effects, which a large supply of mineral substances is in some cases found to produce, or for its possession of the power by virtue of which so large an amount of such substances is taken up by its roots and distributed throughout its living organs.

It was our intention to bring forward many more results, both of the field and laboratory, relating to the important subject of root-culture, had our space permitted it. We have still eighty ash analyses obtained from turnips, the history of the growth of which is detailed in this paper. It would also have been advantageous to give, in less technical language, a short summary of the results arrived at in the course of these experiments, for the convenience of those readers who are more conversant with practical than with scientific agriculture. Having, however, through the kindness of the Journal Committee, already extended our article to a length beyond what is usually allotted to contributors, we must conclude with a brief explanation of the means to be employed in the profitable cultivation of roots, and of the pecular properties which they possess, and which constitute their value as fallow-crops.

A practical farmer, accustomed to consume his turnips upon his land every fourth or fifth year, might be inclined to doubt the correctness of any conclusions drawn from a set of experiments so artificial as the removal of five successive crops of turnips from the same field. It should therefore be distinctly understood that the object of these experiments is not to provide any examples for direct imitation in practice, but to enable us to ascertain the real characters of season, soil, and manuring required for the growth of the turnip, in order that, the principles of its culture being better understood, the practice of it may be more economically carried out. In our experiments upon wheat, given in the last number of this Journal, we showed that the produce of grain, beyond that which the soil and season gave in successive years, was dependent upon the supply of nitrogen; that 100 lbs. of rape-cake, containing 5 lbs. of nitrogen and 80 to 90 lbs. of carbonaceous matter, gave no greater increase of corn than a salt of ammonia containing 5 lbs. of nitrogen and no carbonaceous matter; and that the produce from 14 tons of farm-yard dung upon the same space of ground year after year, was invariably less than that which was obtained from 2 cwts. of ammoniacal salts. The farm-yard dung and rape-cake increased the produce of grain in proportion to the amount of nitrogen which they contained; but as the rape-cake contains only 5 per cent. of nitrogen, and dung frequently not a ½ per cent., or one pound in 200, to what purpose can this bulk of carbonaceous matter be applied? As long as corn is cultivated, it is evidently of little use. Our experiments upon turnips answer this question in a most satisfactory manner. They show distinctly that the production of turnip-bulb depends upon the supply of carbonaceous matter in the soil, and that the true office of the turnip and other root-crops consists in converting the otherwise useless refuse of our corn-crops (straw) into a succulent and nourishing food for animals. During the five years over which our turnip experiments have been carried, in only one instance has the acreage weight of bulbs reached 17 tons. We know that the mineral matter required by the turnip has not been deficient, and in many instances very large quantities of nitrogen have been supplied; but the essential substance, carbonaceous matter, required for bulb-formation, has been but moderately supplied in the form of rape-cake; in one instance, where it was supplied in a larger quantity by dung, the greatest produce was obtained. Having, therefore, shown that to obtain heavy crops of bulbs, large amounts of carbonaceous matters should be supplied to the soil, and that dung is the cheapest source of this substance, the question next arises, What are the best substitutes for it? Dung is an article in which our farm-yards are very apt to be deficient. It might be supposed that if sufficient carbonaceous

matter were once placed upon a farm exporting only corn and meat, the loss in these two substances would not be greater than what would be supplied in return by the atmosphere; but the experiments of Boussingault and Dr. R. D. Thomson show that the amount of such matter respired by an animal, and therefore lost to a farm, is very great; indeed we should not be far wrong if we said that in feeding a crop of turnips by stock one-half of the carbonaceous matter in it is lost to the farm. To restore the loss of organic matter most economically, various processes are recommended: some advocate the consumption of artificial food with the turnip; some the employment of ammoniacal substances to collect carbon from the atmosphere; and some maintain that if the mineral substances composing the ash of the turnip were restored to the soil, it could supply itself with organic matter. To commence with the mineral manures,—Analysis has shown that a great portion of the ash of the turnip consists of the alkalies, potass and soda, and of magnesia—and these substances have been recommended in the formation of mineral manures; we think, however, that a careful examination of the position which the turnip-crop holds in a rotation, and the manner in which its organic and inorganic matters are applied in farm practice, will show that the artificial supply of alkalies can rarely if ever be advocated. A fair crop of turnips would contain in leaf and bulb about one ton and a half of dry matter, of which 250 lbs. would consist of minerals. Omitting those minerals which are of less importance, we may consider the composition of the crop as follows:—

Dry organic matter .	3110
Potash . . .	127
Phosphate of lime .	50
Sulphate of lime . .	40

Of the organic matter, more than one half of the carbon, but probably scarcely one fourth of the nitrogen, is lost to the farm by the respiration and increase of the stock.* The amount of phosphate of lime removed would vary greatly with the nature of the stock consuming the turnips. A breeding flock or young growing animals abstract large quantities to be employed in the production of bone, while full-grown animals require very much less. Of the alkalies contained in the ash of the turnip the stock return to the soil all they take up. Barley generally follows after turnips, the greater part of which is taken to market. A crop of 40 bushels carries off phosphoric acid equal to about 28 lbs. of phosphate of lime and 9 lbs. of potash. The clover following the barley, being consumed by stock, causes a further loss to the farm of organic matter and phosphate of lime, but no

* This *retention upon the farm of nitrogen specially* demands more notice than our space permits.

alkalies; while the wheat removes about 12 lbs. of potash and 30 lbs. of phosphates. We see, therefore, that much of the organic matter of the turnip is lost to the farm by respiration, the phosphate of lime largely in the formation of bone; while the export of potash is so small that the quantity contained in one acre of turnips would not be entirely exported under twenty years. It is clear, then, that unless by actual waste, there is, under an ordinary course of farming, without the use of imported food, a comparatively small decrease in the amount of available alkalies in the soil; but when we consider the vast amount of alkalies existing in the soil itself, and set free by annual decomposition, and that in every well-cultivated farm there will be a considerable quantity imported in cattle food, there can be little doubt that, under ordinary circumstances, the alkalies accumulate in the soil. It may be further remarked, that in our experiments the alkalies, in whatever form we applied them, were always injurious to the vigorous growth of the young plant. Although the export of phosphate of lime from a farm is very much larger than that of the alkalies, the continual use of it as a manure for the turnip-crop could not be advocated upon the ground of mere exhaustion; for it could be proved that where the supply of it to the turnip-crop during successive years has been much greater than what has been removed in produce, the effects of further applications were equally successful.

We are therefore inclined to limit the economical application of mineral manures to phosphate of lime alone, and even then in most cases it is employed not as an element of which the soil is deficient, but as an agent for promoting to a remarkable degree the early and vigorous development of the young plant, and carrying it with rapidity over those stages, any delay in which is attended with great injury, and often with the destruction of the whole crop. The sources of phosphate of lime are guano, bones, and the compound of bones and sulphuric acid, called superphosphate of lime. The latter manure is the form which is found to produce the greatest effect upon the young plant, and especially upon the development of a large amount of fibrous roots. Although strongly acid, it may be drilled with the seed without the slightest injury to it. It must, however, be clearly understood that the bulk of an agricultural crop of turnips depends materially upon the amount of organic matter contained in the soil, without which the development of the power of growth by means of the phosphate will be unavailing. The first application of a mineral phosphate is liable to produce heavier crops of turnips than those which follow, unless the carbonaceous matter taken from the soil by the turnips, and lost by the respiration of the stock consuming them, has been made up by imported cattle food. Rape-cake, as containing a large amount of organic matter,

is an admirable manure for the turnip as a substitute for farm-yard dung; it may be employed in conjunction with superphosphate of lime—the former being sown broadcast, and the latter drilled with the seed. Peruvian guano, which contains a large quantity of ammonia as well as phosphates, is found to be a much more certain manure for turnips in Scotland, where the fall of rain is large, than in those parts of England where it is much less. Indeed the natural agencies of *season* are much more favourable to the growth of turnips in Scotland and the north and west of England than in the eastern counties, where the application of skill and capital, upon a soil well suited to the plant, has gained for them a high reputation. In the south of England, and wherever the comparatively small amount of rain that falls renders the production of the turnip-crop uncertain, the cultivation of the mangold-wurzel might be extended with considerable advantage: it can be sown sufficiently early in the spring to enable it to extend its roots deep in the soil before the dry weather sets in, it is not liable to injury from insects, and it is capable of producing a larger amount of solid food than any other crop in a rotation. The objection raised against it as an exhausting crop arises partly from the small amount of produce which it yields from a given weight of manure compared with turnips; but as the percentage of dry matter is greater, the objection may not be valid. The following Table shows the amount of dry matter contained in various root-crops grown this season upon Rothamsted Farm under ordinary cultivation:—

Percentage of	dry matter in	Long Red Mangold-wurzel .	12·7
ditto,	ditto,	Yellow Globe ditto . .	11·34
ditto,	ditto,	Common Swede (name unknown).	12·2
ditto,	ditto,	Skirving's Swede, purple top .	9·4
ditto,	ditto,	ditto, ditto, green top .	9·4
ditto,	ditto,	Green common Turnip . .	7·9
ditto,	ditto,	Norfolk White	7·83

We see by this table that 10 tons of mangold-wurzel contain as much dry matter as 15 tons of white turnips, and that the difference in bulk between a crop of Skirving's, compared with one of the older sorts of swedes, is due to the difference in the proportion of the water. That the soil on this farm, although not a turnip soil, is capable of producing good root-crops, *under a proper supply of manure,* may be inferred from the fact that this year, which is anything but a good turnip season, an acre of swedes was weighed, the bulbs of which gave 20 tons 10 cwt. Number of plants per acre, 20,120; average weight, 2 lbs. 3 oz. Ten of the largest were found to weigh 112 lbs.

We found in our experiments that the usual percentage of nitrogen could be nearly doubled by the use of ammoniacal manures; but we do not recommend the general *direct* use of

such manures for turnips, notwithstanding that the value of our produce as food depends much upon the percentage of nitrogen it contains.

On some future occasion we shall endeavour to show that, excepting rape-cake, the manures in the market containing nitrogen are more advantageously employed for clover, and other crops of the like kind, than in any other place in the rotation.

If a proper quantity of imported food be consumed upon a farm, the direct supply of nitrogen to the turnip crop by means of artificial manures will certainly not be necessary. An *excess* of nitrogen in the soil produces too large a proportion of leaf, and too little tendency to form bulb. It is true that a crop of turnips having a large proportion of leaf will give a larger amount of manure to the land; but its yield of food will be comparatively small. But, since the manure obtained in such a case previously existed in the soil, the economy of the crop, even so far as its manuring influence is concerned, may be doubted. In fact, so far as our experiments upon this subject enable us to judge, we believe that where the supply of nitrogen to the soil is very great, the amount of it collected from the atmosphere is less, and thus a part of the benefit of the crop would be lost. All the specimens in which we found a high percentage of nitrogen were those in which there was a great development of leaf with a comparatively small tendency to form bulb; and we believe that the high percentage was due to a deficient accumulation of carbon by the plant. Whilst, then, a high percentage of nitrogen may indicate an abundance of it in the soil, the growth of the plant has been in other respects defective. It is probable that the full-grown bulb of such a plant as has only a due proportion of leaf will seldom have a percentage of nitrogen much higher than that which has been usually observed; for with an increased supply of nitrogen there is an excessive production of leaf, and a bulb which, though richer in nitrogen, is not profitably developed. There is, however, a casual advantage in having a somewhat full supply of nitrogen in the soil for those of our turnips which are to be eaten late in the season; for the plants so grown, whilst they may have a less favourable proportion of bulb, yet, owing to the increased vitality and hardiness which result from the nitrogenous manure, the bulb is better fitted to stand the winter temperature without injury. A sufficient importation of food for stock will, however, render the purchase of nitrogenous manures for the turnip crop quite unnecessary; but where such manures are employed, rape-cake will be found to afford a sufficient, and in other respects the most advantageous, means of supply.

Lastly, it must not be forgotten that the tillage of the soil constitutes a most essential element in turnip culture; and that he who sows his turnip-seed upon a badly-cultivated soil is only

throwing away his time and money. The naturally light and porous nature of a *turnip soil* points out what are the requirements of these plants; and when the necessary degree of tilth has been obtained, and the seed sown, the introduction of air beneath the surface of the soil by means of the horse and hand-hoe cannot be too frequent; for it is useless to place a large amount of dung in the soil to be converted into the substance of the turnip, unless the free action of the air is provided for at the same time, by which alone the decomposition of the dung can be effected.

J. B. LAWES.

Rothamsted, November, 1847.

NOTE.—In placing my name to this article I must observe that whatever merit may be assigned to it is mainly due to the skill and talents of Dr. Gilbert, upon whom the responsibility attending the investigation has devolved. Those who have endeavoured to conduct with accuracy only a few experiments in agriculture will be capable of forming some estimate of the labour which so extensive a series requires.—J. B. L.

XXIV.—*Shepherd's Corner Farm.* By LORD PORTMAN.

(Continued from Vol. IV.)

To Mr. Pusey.

DEAR PUSEY,—I send you herewith the final statement of my farm at Shepherd's Corner, that you may insert it in the Journal of the Royal Agricultural Society of England. I must remind you that I have made my experiment under circumstances peculiarly unfavourable to profitable farming. I have, however, converted a district formerly unproductive into a fruitful farm without any loss at the end of my work, but, on the contrary, with the small gain which the account shows. I have changed the rental from 2*s*. 6*d*. per acre into the average rental of the neighbouring arable lands, and thereby augmented the value of the estate to my heirs. I have let the farm to an excellent tenant for a term of twenty-one years, and I have the pleasure of seeing it covered with good crops. I would draw attention to the Field No. 3, where in 1843 I obtained a good crop of turnips by the aid of great pressure of the fold, but in spite of it I had to grapple with the wireworm in 1844, and saved the oats only by a repetition of pressure. Also to Field No. 2, where in 1845 I first tried rape as a preparation for wheat, and succeeded so well, that I have ever since adopted the system on my Bryanston farm with great success. In the account of Shepherd's Farm, in the Journal of 1843, there is an error which I wish to correct, as it is important. The mis-

take is, "where the surface-soil was NOT deeply buried, the crops were least good." It should have been "*most,*" instead of "*not.*" The whole of my experience has proved that it is not wise to bury the surface-soil in the way I adopted in Fields No. 1, 2, 3 of this farm, but it is desirable gradually, year by year, to mix the surface and subsoil, and thereby to improve the fertility of the farm.

I have the pleasure of seeing my neighbours, who occupy lands of similar quality to this farm, converting unproductive districts into fertile farms, avoiding my errors, profiting by my experience, and I am thereby fully rewarded for my labour. I hope that the publication of the accounts, as well as of the system, may be useful to the agricultural community.

Yours, truly,

PORTMAN.

Bryanston, June 24, 1847.

Shepherd's Corner Farm, Durweston.

Field No. 1—*South Free Down*—36 A. 2 R. 22 P.

1843. One year's ley—mown for hay: the crop about $1\frac{1}{4}$ ton per acre; the after-crop pastured by sheep.

1844. Two years' ley—pastured by sheep and prepared for wheat: 14 acres folded by sheep, and manured extra with ground rags, or shoddy. 22 A. 2 R. 22 P. manured with yard-dung and once ploughed.

1845. Wheat. 14 acres dibbled last autumn; seed about $1\frac{1}{4}$ bushe per acre. The season turned out peculiarly unfavourable for thin-sown wheats, and here it proved an almost entire failure—the crop harvested not more than 3 sacks per acre. 22 A. 2 R. 22 P. Chidham's wheat drilled; seed 3 bushels per acre; crop nearly 6 stacks per acre. This wheat is not well adapted for this description of land. The straw grew weak and very spongy.

Field No. 2—*North Free Down*—34 A. 2 R. 37 P.

1843. Oats. A very good crop of Poland and Tartar oats; 13 sacks per acre, and the straw very heavy. The land seeded with 1 bushel rye-grass, 10 lbs. trefoil, and 2 lbs. Dutch clover per acre.

1844. One year's ley. 8 acres fed off by oxen and sheep. 26 A. 2 R. 37 P. mown for hay; crop 1 ton per acre.

1845. Two years' ley. 18 acres of this field dunged and folded, and ploughed as late as April for rape and turnips; the ground once ploughed and the seed drilled in with ashes only: the crop very good. 16 A. 2 R. 37 P., two years' ley, pastured

by sheep and oxen, well dunged with farm-yard manure, and ploughed once for wheat.

[The present tenant reports that in 1846 the best sample of wheat was after the rape and turnips; but that the plant of wheat on the dunged land always had the best appearance. The yield of each piece per acre was about equal.]

Field No. 3—*Willetts*—37 A. 1 R. 25 P.

1843. Green crops. 10 acres winter and spring vetches mown for soiling; the land afterwards drilled with rape and turnips, and manured with guano and ashes: for late feed the crop was pretty good. 7 acres peas of various sorts: crop only 4 sacks per acre: the rape which was sown after the peas failed entirely. 2 acres potatoes; a good sample; produce 65 bags (240 lbs. each) per acre only. 5½ acres hybrid turnips; an excellent crop; a part of the ground was muckled and *heavily* folded, the ground thoroughly well worked, and the seed drilled with ashes. The remainder of the ground was heavily folded, but not muckled. After the ground had been ploughed some considerable time, it was well dragged and harrowed, and the seed drilled deeply with ashes: this part also bore an excellent crop. This experiment gave satisfaction, as no turnips which could be called a crop had before been grown upon this field. 13 acres Italian rye-grass; sown last autumn immediately after wheat-harvest. This did not afford very much feed, the ground being too poor and cold for it, and the plant was very much thinned by the severe winds of March.

1844. The whole field sown to oats; the wireworm becoming very destructive, the field was rolled twice with a four-horse (a 30-cwt.) roller, which stopped further mischief, and saved the crop: the produce 9 sacks per acre. The land sown to grass and clover seeds as before.

1845. One year's ley. Mown for hay; crop about 1 ton per acre.

Field No. 4—*Higher Ball*—34 A. 2 R. 37 P.

1843. Wheat. A wonderful crop of straw; produce of grain 6½ sacks per acre, the grain not very well filled out.

1844. Twelve acres folded over twice for swedes, and manured with guano and ashes: the plant was completely destroyed by the fly. This was afterwards drilled across the former rows with common turnips without any manure: for so late a crop it was pretty good. 22 A. 2 R. 37 P. drilled to hybrid and common turnips, dressed with various artificial manures and a quantity of ashes: the crop very fair.

1845. Oats. Mown very early to improve the straw for winter fodder: produce 11 sacks per acre. The land seeded with saintfoin.

Field No. 5—*Lower Ball*—34 A. 0 R. 35 P.

1843. Wheat. 19 acres manured with Lance's humus and bone: a very heavy crop of straw; the produce of grain $6\frac{1}{2}$ sacks per acre; the sample inferior to the grain of the adjoining piece. 15 acres spring nursery wheat $7\frac{1}{2}$ sacks per acre: this was thought to be the best sample of corn that had yet been grown at Shepherd's Corner.

1844. Two acres potatoes; ridged and dunged; the crops 53 bags per acre. 13 acres peas: crop $4\frac{1}{2}$ sacks per acre. 12 acres rye; fed off by sheep; the land afterwards drilled to turnips and manured with bones and ashes: 7 acres only gave a good crop of turnips. 7 acres vetches mown for soiling: the land afterwards sown to turnips, which produced a partial crop only.

1845. Turnips. Manured with dissolved bones and ashes: about two-thirds of the field a good crop; the best produce after the peas and potatoes.

Field No. 6—*Bittern Field*—23 A. 3 R.

1843. Two years' ley. 8 acres of it pastured by sheep. 15 A. 3 R. mown for hay: 1 ton per acre of hay.

1844. Wheat. 8 acres ploughed last autumn, and then dressed with Daniell's patent manure, which was covered with a light furrow: the crop only $2\frac{1}{2}$ sacks per acre. 5 A. 3 R. drilled with Chidham's White Wheat; Daniell's patent manure drilled immediately under the corn: crop 6 sacks per acre. 10 acres folded over by sheep, and drilled with red and white wheat: crop 6 sacks per acre.

1845. 10 acres common turnips, the land folded over by sheep: a very good crop. 13 A. 3 R. swedes; a very good crop. Both lots were manured with a sack of dissolved bones (our first experiment with this manure), and mixed with about 40 bushels of ashes per acre.

Field No. 7—*Mare Close*—10 A. 2 R.

1843. Two years' ley. Mown: 1 ton per acre of hay, and then dunged for wheat.

1844. Wheat, red and white, but separate; a beautiful sample and an excellent crop: harvested 9 sacks per acre; lost about 1 sack per acre by the beating of the very rough winds at the time of harvest.

1845. Self-sown wheat and vetches; an excellent crop; fed off by sheep, the land afterwards sown to swedes, and manured with dissolved bones and ashes: being late sown, the swedes were not a heavy crop.

RECEIPTS from the Shepherd's Corner Farm from the Years Michaelmas 1842 to Michaelmas 1845.

		£	s.	d.
Michs. 1842 to Michs. 1845.	For wheat sold	1,105	0	0
	Oats sold.	612	0	0
	Potatoes, peas, and swede seed sold	143	14	0
	Winter-keep of sheep on turnips, hay, and corn for 3 years. .	365	13	0
	Summer-keep of sheep on grass, vetches, &c.	334	13	9
	The keep of extra cattle in summer and winter, and the sale of pigs and poultry . . .	159	0	0
	Profit on the purchases of working oxen	30	0	0
	Straw taken from this farm to the Bryanston farm	90	0	0
	Team and manual labour done for Lord Portman by teams kept at this farm, at the usual rate of hire	486	0	0
	£	3,326	0	9
From the Year 1826-7 to 1842	Brought from the last Account, as in Journal, Vol. IV. p. 88 .	10,544	10	0
	Total Receipts . £	13,870	10	9

EXPENDITURE on Shepherd's Corner Farm from the Years Michaelmas 1842 to Michaelmas 1845.

		£	s.	d.
Michs. 1842 to Michs. 1843	Paid for amount of farm labour . .	297	6	7
Michs. 1843 to Michs. 1844	Ditto ditto . .	343	5	3
Michs. 1844 to the end of threshing .	Ditto ditto . .	430	17	6
Years :—1843	Wheat seed	133	0	0
1844	Oat seed.	80	8	0
1845	Seed-peas, seed-vetches, and turnip seed	50	12	8
	Seed-potatoes	7	4	0
	Grass seeds	36	18	0
	Artificial manures purchased . . .	256	0	0
	Artificial food purchased (oil-cake, &c.)	128	0	0
	Poor, Way, and Church rates and Taxes	168	0	0
	Blacksmith's bills, plough-iron & rakes	30	0	0
	Harness-maker's bills	8	10	0
	Carpenter's and wheelwright's wages .	35	0	0
	Farrier's bills	3	0	0
	Cost of sheep-hurdles	15	0	0
	Repairs and incidental expenses . .	50	0	0
	Rent for 3 years, including Tithe . .	714	0	0
	Interest of capital employed at 4 per cent.	70	0	0
	£	2,857	2	0
From the Year 1826-7 to 1842	Brought from the last Account . .	10,455	18	7
	Total Expenditure. .	13,313	0	7
	Balance in favour. .	557	10	2
	£	13,870	10	9

XXV.—*On the Use of Peat-Tiles for Draining.* From his Grace the Duke of Richmond.

There was, close by the park of Gordon Castle, a pretty large loch surrounded by swampy ground, altogether from 22 to 24 imperial acres, famous for wild ducks breeding in. This place was, in 1837, cleared of alder bushes, and a deep open leading-drain cut across it. In June of the same year a great quantity of peat was cut in the shape of drain-tiles  but a great deal *thicker*: they were carefully dried on the moss where they were cut, and then put under cover for the winter till they were required. As soon as the drains in the said swamp were cut, peat-tiles were laid in them, in *July*, 1838. The drains were from 24 to 30 inches deep, and 36 feet apart; and they have dried the ground as effectually as any other tiles would have done. There were not peats enough to do half the ground, but the *wettest* of the ground was done with the peats; the rest of the collecting-drains were done with water-stones. The ground is now in a high state of cultivation. Some yards of one of these peat-drains were opened on the 1st of November, 1847, and the peat-tiles taken out, and all found perfectly sound and hard, and the drain was quite clear, and showed that it had work to do in wet weather. There is in the drain a fall of only 1 foot in 84 feet length. With the proper spade for cutting these tiles out of the moss, a man can cut about half the quantity that he could of fire-peats.

E. Wagstaff.

XXVI.—*On the Autumn Cleaning of Wheat-Stubbles upon Light Land.* By Ph. Pusey, M.P.

In so old an art as farming, the adoption of new inventions is very hazardous: but a good local usage, when we can find one, unites the promise of novelty with the warrant of practice. Now Mr. Raynbird, in his excellent account of Suffolk farming, printed in the present Journal, states that on the light soils of that county, "if a dry autumn succeeds an early harvest, we shall, in all probability, see the *whole* of the fallows cleared of couch and other rubbish *before* the clover layers are ploughed for wheat." This method appears to me the greatest improvement that could be introduced on our south-country farms. Our present habit is to break up our stubbles—often full of couch-grass—during the winter; and about May to prepare them for turnips by three or four ploughings, with harrowing, raking, and burning. The disadvantages of this practice are plain to practical farmers: first, the wear and tear of horses, with the wages of labourers; these form a heavy item in the valuations of outgoing tenants for Acts

of Husbandry, and are set down at not less than 2*l.* an acre. Next, if the weather be wet, the work is most imperfectly done. Lastly, even if it be dry, the land is reduced to a dusty and hollow state, unfavourable to the turnip, which on some light soils at least strikes best upon land that has settled down, sometimes called a stale furrow. Yet if farmers used to this dilatory proceeding were told that swedes and turnips could be sown after one ploughing, they would smile at the proposal as a pure vision of abstract philosophy. Some incredulity is indeed wise and prudent, nor should any advice be adopted on a large scale without the stamp of experience. I am desirous, therefore, to strengthen Mr. Raynbird's statement by the evidence of another Suffolk farmer, Mr. Bond, jun., of Hacheston, near Wickham-market. His account, which deserves serious attention, is as follows:—

"In this district the labour of making fallows has, within the last few years, been greatly diminished by the practice of forking out the couch-grass before ploughing the wheat-stubbles. By far the greater portion need only be ploughed *once*, as a preparation for the root-crop: and by some the lands are sown with rye, tares, or winter-oats. These crops are intended for sheep-feed, and thus the number kept is greatly increased.

"When this practice of growing green crops, instead of fallowing, is adopted, women and children are employed to look over the wheat-stubbles directly after harvest (accompanied by a man to see the work carefully performed) to take out couch-grass and docks. This, on a well-cultivated farm, *from being made a system of*, is quickly and cheaply done.

"Rye is largely sown, coming soonest to feed, and is drilled at the rate of two to three bushels per acre; the more seed the earlier and greater will be the quantity of feed. Rye is indispensable to the flock-master, and carries the sheep from turnips till grass. A small portion is sometimes manured in order that it may come stronger and sooner; this is mown and carried home to be cut into chaff with straw, and given to the horses.

"Tares are drilled at from 8 to 10 pecks, to follow in succession for spring feed after the rye is finished.

"Winter-oats are drilled at the rate of 3 or 4 bushels per acre. They last longer than rye or tares, if fed close (and they cannot be fed too close), when they will continue to sprout quickly till stopped by the plough. On farms where this system is pursued, rye is first fed off, and the land ready to plough; then tares; and lastly, the winter-oats. After whichever it may be, the land generally ploughs up in a friable state, and may be brought to a fine tilth by rolling and harrowing, when globe, beet, or swedes are drilled. If not ploughed by May, the land is generally drilled with white turnips. By some the rye, tare, or oat stubbles are scarified with Biddle's scarifier previous to ploughing. Beet and turnips are grown quite equal to those on land made a fallow of, and worked about in a regular way."

This last point is the only one about which there may be some doubt; at least farmers think that, after vetches, some land is not kind for turnips. Mr. Bond's whole statement, however, is most valuable; not that it is new to grow either rye or vetches for spring keep. What is new is to grow them on so large a scale: what is especially new and especially deserving the attention of us south-country farmers, is the autumn-cleaning of our wheat-stubbles. I say—of south-country farmers, because it is now an admitted fact that we cannot sow swedes or turnips early, nor thus compete in the bulk of that crop with the cooler parts of the island. Feeding off rye and vetches and winter-oats will therefore less interfere with our turnip-sowing. During our June droughts the vegetation of young crops on our shallow soils is almost suspended. We have no choice, then, but to take an early green and a late root crop, if we would make the most of our land. Two objections, indeed, may be made to the early cleaning of wheat-stubbles; one by the landlord, who wants harbour for partridges; the other by tenants of the old school, who let their flocks run over this poor but dear keep, feeding on couch till December. I am sorry to say that in taking to land I have had this kind of food valued to me at 10*s*. per acre. But such prejudices will, of course, give way. For my own part, I have found already the advantage of the practice, and intend to follow it up. I hope to raise sheep-keep on most of my wheat-stubbles, except those intended for mangold, which should be sown early in spring; and the point I shall aim at will be, as far as practicable, never to see my land naked. I have now very few acres of wheat-stubble left to clean, and the greatest part of my farm is green within three weeks of Christmas. The change of system may, of course, require time, and the more time the fouler the land. But if a farmer will only believe that the change has been made by others, will consider the expense and worry to be saved by cleansing his land once for all, as well as the advantage of early keep for his flock, I think he will admit that the Suffolk practice deserves imitation.

Pusey, Dec. 5, 1847. Ph. Pusey.

XXVII.—*On a Variety of Italian Rye-Grass.* By W. Dickinson.

To Lord Portman.

My Lord,—Your Lordship's request that I should furnish the readers of the Royal Agricultural Society's Journal with all the information I possess as to the culture of Italian rye-grass is the

only apology I shall offer for troubling them a second time on that subject.

In the first instance, I had to communicate a new method of cultivating a peculiar plant, the result of which was as startling as it was new, whereby nine or ten crops of excellent green food had been obtained between March and December; being cut in the former month and watered with liquid manure, consisting of one-third of pure horse urine and two-thirds of water, distributed from a London street water-cart passing once over the plant immediately after the grass was cut, one watering being sufficient for one crop. That report created considerable interest, and induced noblemen, gentlemen, farmers, and traders to test the system with the same object, the result of whose practice upon various soils, with different treatment, I now purpose to lay before the readers of the Journal, feeling assured there is matter well worth the consideration of practical agriculturists. I think it important that all the information I have been able to collect, bad as well as good, should be set forth; if, therefore, my paper is somewhat tedious to read, it may be a palliation to know it was much more troublesome to collect.

The method I then recommended was to prepare the land by ploughing, cleaning, and reducing it to a fine surface in the month of August or September, to sow by a broadcast machine two bushels of seed per acre (three, I think, is better, sown at twice by crossing the land with one bushel and a half each way), or four bushels per acre by the hand, to harrow lightly in, hand-weed the first growth, and, as soon as there was about 18 inches of grass, to cut it for green food; watering the plant with the liquid day by day immediately after the grass was removed, and so continue to cut and water, cut and water, from March till November. The plant is a biennial; after two years the land may be ploughed and re-sown if required: it will be seen in how few instances this plan has been adopted, and, when it has, in almost every case, in all kinds of soils, success has followed the operation.

I have applied to about 90 persons, to whom I supplied seed, for information, and have received 44 answers; 12 of which give no information at all, and so must be omitted.

I shall now proceed to the details, classing the reports into soils and subsoils, showing the means used and the amount of produce obtained:—

1. *Sand upon Limestone.*—Shallow and hot; entirely failed.—Hon. P. J. Pierrepont.

2. Sown August; no manure, no urine; first crop 3 feet high in May; second, 2 feet 6 inches first week in August.—Rev. Thomas Cator.

3. *Light Dry Sand upon Red Sand.*—Sown September; no urine; produce, two crops, each 18 inches; as hay one ton and a half per acre.—His Grace the DUKE of BEDFORD.

4. *Light Soil, Sandy Subsoil.*—Sown October; light dressing, stable-dung ploughed in, and dressed after cutting with tank-water from the village; seven crops; fed twice; mown twice, with 3 feet 6 inches of grass to each crop; fed twice again, and had 16 inches of grass standing September 14; the crops weighed as green food 30 tons per acre.—J. WHITWORTH, Esq.

5. *Red Sandstone.*—Sown September and October; dressed with 13 cwt. of Ichaboe guano to the acre, and produced a net profit of 7*l*. 9*s*. 8*d*. per acre. This valuable paper is attached entire, and is highly recommended for perusal.—Capt. BULLER.

6. *Sand, Subsoil Stonebrash,* 12 *inches of Sand upon Stonebrash.*—Sown September; dressed with farm-yard liquid; two crops; one cut green, and one for seed; as hay, 25 cwt. to the acre.—R. S. HOLFORD, Esq.

7. *Sandy Loam upon Sandstone Brash.*—Sown October; dressed with rotten dung before sowing in the spring with 2 cwt. of guano to the acre, and with tank-liquid after first crop; two crops; one 18 inches, one 14 inches high.—C. WALKER, Esq.

8. *Sand upon Gravel.*—Sown September; 3 feet sand upon gravel; dressed with rotten dung; two crops; May, 2 feet of grass; July, 1 foot and thin.—THOMAS TURNER, Esq., President, Veterinary College.

9. *Sandy Loam, Open Subsoil.*—Sown February; dressed with urine before sowing, and $1\frac{1}{2}$ cwt. of guano to second crop; three crops, 18 inches each, 20th May, 10th July, 10th September.—THOMAS BULMER, Fochabers, Gordon Castle, Scotland.

10. *Light Soil, Gravelly Subsoil.*—Sown November; dressed with farm-yard dung in October; no urine; three crops; 3 feet of grass to each.—C. PORCHER, Esq.

11. *Loam upon Gravel.*—Not drained, no manure, no urine, except upon small quantity, and considers crop would have been treble with plenty of urine; fed with ewes and lambs in spring; yielded two crops, one of seed; 172 bushels off 3 acres.—G. WOOD, Esq.

12. *Heath upon Hard Native Soil.*—Sown October; dressed with farm-yard manure ploughed in, and guano dissolved in water; two green crops six weeks apart; a third crop of seed; grass very long, and now feeding it off (September 17).—LAWRENCE WYLIE, Esq.

13. *Light Black Mould upon Yellow Sandy Loam and Gravel.*—Sown September; dressed with cows' urine, house drainage, soapsuds, water-closets and farm-yard water. Four crops: April 14, June 8 (cut too late, and made into hay); August 6, for seed; and, September 10, grew so strong, and so covered the land, it killed all the weeds. First crop 2 feet high, and as thick as it could stand upon the land; was ready earlier than rye on one side of it, and lucerne on the other.—ROBERT GUNTER, Esq.

14. *Light Soil, and various Subsoil; Light Surface upon Sandy Marl.*—Sown October; drained 3 feet; dressed with farm-yard dung before sowing, and with urinal dressing after each cutting; three crops, 3 feet each.—W. Heap Hutchinson, Esq.

15. *Sandy Loam upon Clayey Chalk Marl.*—Sown October; drained 3 feet deep; no dressing, no urine; three crops up to August 23, each 2 feet 4 inches high.—G. Gilliatt, Esq.

16. *Loamy Subsoil, Stiff and Sandy.*—Sown September; drained 2 feet 6 inches; no manure; four crops, 18 to 20 inches high.—Edwin East, Esq.

17. *Light Clay Loam.*—Sown September; not drained; dressed with tank-water after cutting; four crops in six months.—Rd. Dyson, Esq.

18. *Clay and Flints, Subsoil Chalk.*—Sown September; three quarters of an acre; not drained; lightly dressed with dung; no urine; kept forty-one year-old Southdown sheep from April 22 to May 25; cut for seed July 2; produce 37 bushels; cut for horse-food August 15, which it kept twenty-one days; the seed-crop made into a stack of hay 30 feet in circumference.—Rev. J. Phelp.

19. *Clay upon Gravel.*—Sown end of October; no drainage, no manure, no urine, and wet; one crop half a ton to the acre, and fed once.—R. Allfrey, Esq.

20. *Strong Surface, Clay Subsoil, Stiff Marl on Clay.*—Sown in September; part drained, and part not; dressed on surface with dung, no urine; succeeded admirably in part, and failed in part.—G. Harrison, Esq.

21. *Good Loam, Retentive Subsoil.*—Sown in October; drained 30 inches, and subsoiled; dressed after first cutting with 10 tons of rotten dung, spread on surface; two crops of seed, 20 to 24 inches of grass to each.—W. H. Little, Esq.

22. *Stiff Loam upon Clay.*—Sown in September; drained 2 feet; London dung ploughed in; no urine, but used nitrate of soda after second with success. Three crops up to September, and partly fed; two first crops produced 6 loads of hay to the acre.—Josiah Hunt, Esq.

23. *Stiff Mould upon Stiff Clay.*—Sown September; partially drained; dressed part with tank-water, part with nitrate of soda, and part with guano. Three crops: April 28, 2 feet 6 inches high; June 1, 2 feet; July 1, nearly 2 feet, and thin.—Jno. Hoper, Esq.

24. *Sandy Loam upon Clay; Fresh Land.*—Sown October; drained 3 feet; no manure, no urine. Three crops: May 1 for hay; July 10, seed; September 8 for seed again, 2 tons per acre. Each crop of hay double any other crop of grass.—D. S. Hayward, Esq.

25. *Fresh Common Land upon Clay.*—Sown October; no drainage, no manure, no urine; four crops from April 4 to August 8.—J. Cheal, Esq.

26. *Heavy Loam upon Clay.*—Sown September; drained 30 inches; dressed lightly with turf and night-soil, and watered with cows' urine.

Six crops: March 5, May 1, June 8, July 17, August 19, end of September; each from 2 to 3 feet high.—Jas. Bowley, Esq.

27. *Sandy Loam upon Clay.*—Sown October; partially drained; dressed with stable-dung in October, and watered with urine and water. Four crops, 2 feet 6 inches to 3 feet high, and fed in November.—E. Tattersall, Esq.

28. *Strong Land.*—Sown the last week in October; badly drained; exceeding wet in winter, and hard as bricks in summer; each crop watered with cow-shed drainage. Three crops to July 3: cut in April rather less than 3 loads to the acre; in five weeks rather more than 3 loads to the acre; the third in seed, July 3.—Messrs. Noble and Mee.

29. *Strong Loam upon Clay.*—Sown August; drained 33 inches; dressed with dung and urine, part three crops, part four, and part five; with 14 inches on land in November; in March, 18 inches; May, 33 inches; July, 28 inches; August, 26 inches; one crop of seed.—J. A. Slack, Esq.

30. *Loam, Subsoil Clay upon Sandstone.*—Sown October; drained 2 feet 3 inches; watered, after each cutting, with tank-water, as long as the horses were in stable; afterwards 7 lbs. of guano were put into water-cart, and filled with water. Five crops: March 24, May 19, June 25, August 1, September 7. First, 14 inches of grass; second, 2 to 3 feet; third, 3 to 5 feet; fourth, same; fifth, 18 to 24 inches. Part of second crop, cut and weighed green, 16½ tons the acre; dried and made into hay, 4½ tons. Part of third weighed with the same result; fourth equally good; first and fifth estimated each at half.—W. R. Stansfield, Esq., M.P.

31. *Clay upon Clay; Strong Clay upon Yellow Clay.*—Sown September; not drained; dressed with stable manure before sowing; three crops, 18 to 20 inches high.—Messrs. J. and E. Walker.

32. *London Clay.*—Sown September; badly drained; dressed with slaked lime. In September fed with sheep, and one crop of grass 3 feet high. One or two lands watered with urine, with no better effect.—E. Spencer Trower, Esq.

Copy of a Letter from Captain Buller to W. Dickinson.

Sir,—I think I can give a satisfactory answer to your inquiries respecting the Italian rye-grass. The 20 bushels of seed which you sent to me last year were sown, at three different periods, on 6 acres of ground, part of my farm at Whimple, in the county of Devon, half way between Honiton and Exeter. The ground is of moderate quality, on the red sandstone formation, worth from 35*s.* to 40*s.* per acre rental. This particular field had been only partially drained. In 1843 it was sown with barley and clover-seed; and in 1844 and 1845 it had been three times mown. In July, 1845, I ploughed it, and made what we call a bastard fallow. On the 13th of September I manured 2½ acres with 13 cwt. of Ichaboe guano, and sowed 8 bushels of grass-seed. On the 27th of September I manured 2½ acres more, and sowed 8 bushels more seed; and early in October I sowed the remaining acre in the same way.

The seed first sown came up remarkably well, and soon covered the

ground with a luxuriant herbage. The second and third sowings were much thinner in the plant, and much less vigorous in appearance all through the winter. Still the whole field was of a luxuriant colour, and the appearance of the crop was much remarked by agriculturists in the neighbourhood. In the spring it grew most vigorously, but the excessive wet made it difficult to know what to do with it. However, on the 23rd of March we began to stock it with sheep. The grass was then about 18 inches high. The sheep were frequently removed in consequence of the rain, but an account was kept of the numbers and of the days; and by this account it appears that $2\frac{1}{2}$ acres of grass kept fifty-three sheep and forty-eight lambs for fourteen days between the 23rd of March and the 2nd of May. On the 2nd of May we began to mow the remaining $3\frac{1}{2}$ acres for the horses and bullocks in the yard. The produce kept eight large cart-horses, four feeding bullocks, and one bull, for thirty-five days. The horses were in constant work, and both horses and bullocks were kept exclusively on the grass: they appeared to like it, and did well. I should state that the bullocks had been previously kept on mangold-wurzel and hay, and the horses on hay, carrots, and corn.

In May I had the grass from one square rod of ground cut and weighed. The weight was 144 lbs., or $10\frac{1}{2}$ tons per acre. We finished mowing on the 6th of June, when the grass was left for seed, which we began to cut on the 2nd of July. The seed was cut as it ripened; and the weather being fine, it lay in the swarth for one whole day, when the mowers quietly gathered it into small bundles or sheaves, tying it with the grass itself, which was about 3 feet in length.

As the seed shells very easily, I had provided some coarse cotton sheeting, which cost about 4*d.* a square yard, and had it stitched together in two pieces of about 20 feet square. These were laid down in the field, the sheafs nearest at hand laid on the sheeting, and lightly tapped over with the flail. The process is very simple, and two men and a boy will in this manner readily thresh 3 acres of seed in a day. It is necessary, however, to be very careful both as to the time of cutting and the time of tying up, or otherwise the best of the seed will be lost.

The five acres yielded 96 bushels of clean seed, and the remaining acre about 19 bushels—total 115 bushels.

As soon as the seed was threshed it was put into bags and taken to a large loft, where it was spread thinly over the sheets on which it had been threshed. It has a strong disposition to heat, and a man was constantly employed in keeping it turned, while in fine weather it was taken out and dried in the sun.

As soon as the seed had been cut and the ground cleared, the field was manured, part with good rotten dung at the rate of 10 loads per acre, part with liquid manure from the farm-tank, and the remainder with guano at the rate of 4 cwt. per acre; of these the guano seems to be most efficient and the solid manure least, but I rather think the liquid manure had been too much diluted. At this moment (Sept. 2) the grass is again running up for a second crop of seed, and may probably be fit to cut by the latter end of this month.

There were about five loads of straw, apparently of excellent quality, and not much inferior to hay.

I will now give an estimate of the cost and the produce of the crop. It is an estimate only; but I shall state each head, both of expense and return, separately, that others may form their own opinion and correct what may appear to them erroneous.

In estimating the keep of large cart-horses in constant work at 7*s.* per week I think I am under the mark, and I much doubt whether I usually keep my horses during the month of May for less than 10*s.* per week. In this, however, as in other respects, circumstances vary, and the correction is easy.

Dr.	£	*s.*
3 ploughings, 6 acres, at 7*s.* per acre	6	6
Rolling, dragging, working, and sowing, at 7*s.* per acre . . .	2	2
1 ton 12 cwt. of Ichaboe guano, at 8*l.* per ton	12	16
20 bushels of seed, at 8*s.* per bushel	8	0
Carriage of ditto	0	10
Mowing, threshing, and carrying, at 10*s.* per acre	3	0
Sheeting	1	10
10 loads of manure, at 7*s.* per load	3	10
1 ton of guano	8	0
Watering with liquid manure .	0	15
1 year's rent, rates, taxes, and tithes	16	10
Total	£62	19

Cr.	£	*s.*
53 sheep, 14 days, at 6*d.* per week	2	13
48 lambs, ditto, at 3*d.* per week .	1	4
8 horses, 4 feeding bullocks, and 1 bull, 5 weeks, at 7*s.* per week each	22	15
115 bushels of seed, at 8*s.* per bushel	46	0
5 loads of straw, at 25*s.* per load .	6	5
Total	£78	17
Expenses	62	19
Balance	£15	18

To this must be added the crop of seed now ripening, worth at least 20*l.* (say)	£20	0	0
Straw	3	0	0
And a further crop of grass to be cut in October, or left as keep for sheep in the spring (say)	6	0	0
	6)44	18	0
Profit per acre	£7	9	8

I have estimated the seed at 8*s.* per bushel, that being the price that I paid to you last year, but by inquiring this day in London I find that the present market price is 11*s.* 6*d.* per bushel.

In the spring I intend to plough for oats. It is to be observed that so rapid is the growth of this grass that no weed can live or can seed with it. The ground seems perfectly clean, and I consider that in condition it has much improved, and that it will be in excellent order for oats.

Much as my expectations were raised by what I saw on your farm last year, I have no reason to be disappointed with the present experiment; and I am now about to sow 9 acres more for another season. At the same time, I think, there is one thing which, not being attended to, is likely to occasion frequent disappointment in the growth of Italian rye-grass. I think it is not generally sufficiently considered that no plant which yields an unusally large and valuable produce can be grown without an unusual supply of manure. No land will support without exhaustion crops of extraordinary burden with the ordinary supply of manure. I believe this rule to be without exception, and not applicable to Italian rye-grass

alone, but to all heavy and at the same time valuable crops. I am led to this remark by what has already occurred, for when I have been asked what dressing I have used, and mentioned 9 cwt. of guano per acre, the reply has always been, "Is not this enormous?" To which I can only answer—"Look at the produce."

From what I saw at your farm last year, as well as from my own experience in this, I have a full conviction that upon good deep heavy soils, with abundance of manure, and especially liquid manure, it is possible to grow 40 or even 50 tons of rye-grass per acre in a single season; and if so, the question for a practical agriculturist is, What is the value of a ton of rye-grass, and what is the value of a ton of manure; and he will then be able to say how many tons of manure he can apply with a prospect of profit.

It seems especially calculated for deep heavy lands near the farm-yard. A capacious liquid-manure tank, with a liquid-manure cart so contrived as to take out the liquid manure and bring back a load of cut-grass, would greatly increase its value, and in the absence of these guano will be found no bad substitute.

I am, Sir, yours very faithfully,
T. W. Buller.

15, *Sussex Gardens, London, Sept.* 2, 1846.

These practical deductions inform us, my Lord, that this valuable plant may be grown upon almost every kind of soil by judicious treatment with unbounded success; and it may be interesting to know the loss of weight by drying it. A yard of grass was cut for Captain Buller, September 19, being the fourth or fifth crop of that year, and after seed had been taken, it weighed as grass $5\frac{3}{4}$ lbs. (12 tons 8 cwt. to the acre); dried twelve days in the air it became reduced to $2\frac{3}{4}$ lbs. (5 tons 18 cwt.); hung up three days in a kitchen, with 65 to 75 degrees of heat, it became 2 lbs. 10 oz.; then roasted in a sack before the fire till it would rub to powder in the hand, it weighed 2 lbs. $6\frac{1}{2}$ oz. (5 tons 3 cwt. the acre).

No. 1. The hot limestone entirely failed.

No. 2 produced, without manure, solid or liquid, up to the first week in August, 5 feet 6 inches of grass.

No. 3, sand upon sand, produced without liquid but little at Woburn, while in Warwickshire (Nos. 4 and 5) it produced seven crops by September 14, and in Devon (No. 5) a net profit of 7*l.* 9*s.* 8*d.* per acre, with the enormous outlay of 13 cwt. of guano to the acre.

Nos. 6 and 7. Two growers have sown the plant in sand upon stone-brash without success; pains seem to have been taken in these cases; it must be said to have failed in both, and this is the only soil in which it has not generally succeeded.

Nos. 8 to 13. Sand upon gravel. All remunerating crops except No. 8. The whole of these soils were unlikely to produce good crops in so hot a summer, and perhaps many of them would have grown very little grass of any other kind.

Nos. 14 to 18. Light soils, various subsoils: none less than three, and most of them four crops in six months.

No. 19. Clay upon gravel; no drainage, very wet, no manure, no urine, very little produce.

Nos. 20 to 30. Loam upon clay. Three, four, five, six crops have been obtained from these soils; the better drained have been most successful. The produce from No. 30 is well worth close attention; for while 7*l.* 9*s.* 8*d.* net profit per acre has been obtained from No. 5, with 13 cwt. of guano to the acre, a much larger quantity has been produced in Yorkshire by a small quantity of guano reduced to liquid; 18 tons of hay, or 66 tons of grass, per acre, being the amount of produce.

Nos. 31 and 32 are London clays, without drainage, with bad crops. Upon this soil, moderately underdrained, my experiments were commenced and have been carried on. I have never failed to produce every year, from a portion of grass not kept for seed, from seven to ten crops. I have known five produced in one summer without a single atom or drop of manure. I have found the plant sickly and weak where my subsoil was wet, healthy and vigorous where it was dry. I have been convinced for some time it luxuriates in a dry subsoil rather than not retentive, that it will grow rapidly in the strongest clays if not poisoned with stagnant water, that it grows fast in any light soil well irrigated with liquid manure. I have grown it in sand from the sea-shore, moistened with liquid manure. The dressings I should place in the following order:—Urine decomposed in a close tank, one-third urine, water or dung-water two-thirds, guano dissolved 2 cwt. or 3 cwt. in 3300 gallons of water for an acre, during the months of March and April; if the surface of the land be wet the guano may be used solid, as the cart injures the plant in wet weather, and then I should advocate a larger quantity. In June, July, and August, I think nitrate of soda, 2 cwt. dissolved in 3300 gallons of water to the acre, or powdered only, will be found an excellent dressing.

As the sun loses its power I would again adopt the warmer manure—urine or guano. I do not place guano as an equivalent to urine; I place it as a substitute when urine has not been saved in sufficient quantity. It may be had in large quantities upon every farm: by taking as a preliminary step the construction of tanks, and draining the stables, cattle-sheds, piggeries, men's urinals, privies and water-closets of dwellings into them, before the land is ploughed to sow the seed, a larger quantity is collected than is usually calculated. I think no man has, in the first instance, made tanks enough to contain the urine made on his farm during the winter months to be applied during the summer.

Knowing something of the value of urine, and the profit to be derived from it, I am the more anxious to induce others to try it, and will therefore take this opportunity of saying something about the mode I have adopted to collect it and the expense of the tanks to retain it, which may be useful to those who have not yet set about so important an operation in agricultural pursuits.

My land is clay, 250 feet deep; in this soil only have I had

experience, so for this only do I prescribe. Having well considered where the liquid is to be used as well as where it is made, and resolved upon the most convenient situation, I have a hole dug full 7 feet in diameter and 12 feet deep, the bottom being shaped like a basin and well rammed with a little water into good puddle. The construction of the tank is commenced by the bricklayer forming a circle with bricks (4-inch work) round an opening of 5 feet, leaving a space behind the brick-work to be filled and rammed well in with clay-puddle by the labourers as the building is worked up, no mortar being used with the bricks or anything else till the dome is to be formed; mortar or cement is then required, the roof is arched in, a man-hole left in the centre of each, tank and covered with a 3-inch yellow deal cover (2-inch oak would be better). One of these tanks, containing 1000 gallons, costs 2*l.* 17*s.* 6*d.* in the following items, calculating to farmers who have the horses and carts in possession:—

	£	s.	d.	
Two farm-labourers, each ½ day . .	0	2	0	Occupied in digging the hole, carting away clay, preparing puddle, and ramming
Two labouring lads, each 1 day . .	0	3	0	
One man, 1 day	0	2	0	
Two others, 1 day	0	5	0	
One bricklayer, 1 day	0	4	6	
One ditto labourer, 1 day	0	2	6	
Three horses and carts drawing away ¼ mile, for want of nearer shoot, ½ day	0	4	6	
8 feet of 3-inch deal for cover, at 5½*d.* per foot	0	3	8	
Labour and nails	0	0	10	
Lime and sand for man-hole . . .	0	2	6	
900 place bricks	1	7	0	
	£2	17	6	

Several of these tanks should be made adjoining each other; they then form a most excellent filter to keep back any hay or straw that would prevent the egress of the liquid from the water-cart, receiving it into the first from the stables, and pumping it out of any other one of them. It must be observed, also, the tanks being formed, the drainage into them is the next feature to be considered. I have adopted a mode economical and effectual by laying down in the pavement what is called at the iron-works an angle-iron gutter of very small size, and covering the surface of it with a flat iron bar, just to lay within the surface of the gutter, wherein all the urine is received and conveyed away immediately, and all the straw, dung, and dirt is kept out; this is highly advantageous, as the urine is conveyed away immediately, without escape of ammonia, and the little gutter may be un-

covered as often as you please, and swept out with a broom. There is no under-drain to get stopped; all can be seen and kept in order by a commonly useful person without the aid of what is called a tradesman. I should like to see three of these little gutters down a stall, whereby all the urine would be caught; 3 gallons per day from each moderately sized horse, more from cart-horses that drink freely, considerably more from cows, and a much larger quantity from pigs than is usually calculated. If all the water is caught from farm-horses, cows, pigs, farm-servants, household servants, the tanks would be filled very quickly; and whenever the tank containing 1000 gallons of urine is filled the second time and properly applied to Italian rye-grass, the result will show it is not too high an estimate to calculate the tank and drains paid for. The first application will convince the grower of 10 acres of this grass that his present stock is insufficient to eat it. He must add to it, and thereby increase the quantity of urine considerably, and so go on to keep a much larger farming stock altogether. The often-asked question, "How shall I obtain urine enough?" will cease to be asked, and the amount of solid fæces so much increased as to obviate the necessity for a constant outlay of capital to procure it.

I have the honour to subscribe myself,

My Lord,

Your Lordship's very humble Servant,

WM. DICKINSON.

7, *Curzon-street, May Fair, London.*

END OF VOL. VIII.

London: Printed by WILLIAM CLOWES and SONS, Stamford Street.

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TO

THE ROYAL AGRICULTURAL JOURNAL.

VOLUMES ONE TO EIGHT.

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ILLUSTRATIONS.

London: Printed by William Clowes and Sons, Stamford-street.

Royal Agricultural Society of England.

1846—1847.

Honorary Members.

AUSTRIA, His Imperial Highness the Archduke John of.

BUCKLAND, The Very Rev. WILLIAM, D.D., Dean of Westminster.

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COLMAN, HENRY, Agricultural Commissioner of the State of Massachusetts.

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VAN DE WEYER, M. SYLVIAN, Belgian Minister.

WAY, JOHN THOMAS.

Royal Agricultural Society of England.

GENERAL MEETING,

12, Hanover Square, Saturday, May 22, 1847.

REPORT OF THE COUNCIL.

The Council have to report, that, since the last General Meeting of the Society in December, they have had their attention particularly directed to the following general subjects of inquiry, viz. :—

I. Finances;
II. Country Meetings;
III. Diseases of Cattle generally;
IV. Analysis of Ashes of Plants.

At that time the funded property of the Society consisted of 7000*l.* Stock; it has now been raised by further investments of capital to the amount of 8999*l.* Stock: since the same date the sum of 3671*l.* has been received on account of annual subscriptions and life compositions, of which 487*l.* consisted of arrears paid up on account of former years. The following arrears, however, amounting to 3862*l.*, still remain unpaid:—

1843	£431
1844	856
1845	1258
1846	1317

In order to afford increased facilities to Members in the payment of their subscriptions, the Finance Committee have made arrangements for their collection within the range of the London district.

During the last half-year, 45 Members have died, 140 have been struck off the list, and 147 new Members have been elected. The Society now consists of

91 Life Governors,
195 Annual Governors,
607 Life Members,
5478 Annual Members,
20 Honorary Members;

making a total of 6391 Members. The Finance Committee will lay before the Members a statement of the accounts of the Society for the half-year ending on the 31st of December last, as audited, agreeably with the bye-laws, on the 21st instant, by the auditors elected on the part of the Society.

The Council have received from the authorities of Northampton the liberal subscription of 1200*l.* towards the expenses of the Country Meeting of the Society to be held in that town in the month of July next; and on account of the well-known position of Northampton, its central situation, and the ready access to it from every part of the country, there is every reason to expect a numerous assemblage of visitors. From the circumstance of a larger number of implements having been entered for this Meeting than on any former occasion, and in consequence of the very extensive applications daily making by intended exhibitors for entries of stock, the Council anticipate a most gratifying exhibition in each of the departments of the show. The local authorities of the town are engaged in making every arrangement for the comfort, convenience, and economy of the visitors expected on the occasion; and the directors of the London and North-Western Railway have signified their willingness to promote, by every means within their power, the convenience of the Society and the accommodation of the public generally during the period of the Meeting.—The Council have decided that the Rev. Mr. Huxtable should be requested to favour the Members, on the Tuesday evening in the week of Meeting, with a statement introductory to a practical discussion on the subject of the Growth of Turnips by means of artificial manures, the particular combination of

manure best adapted for particular cases, and the readiest mode of detecting adulterations in the several preparations now so generally on sale; and that Professor Way should also be requested to favour the Members on the same occasion with a Scientific Outline of the conditions affecting the growth of the turnip, and a chemical explanation of the action of the different manures employed. The Council have further decided that, on the Wednesday evening in the week of meeting, Mr. Thompson should be requested to favour the Members with a statement introductory to a practical discussion on the comparative advantages and disadvantages of the Thick and Thin Sowing of Wheat. The Council have no doubt that the discussion of these important topics will lead to the communication of many valuable results of practical experience. The Council have decided to hold the Country Meeting for the Yorkshire District, in the year 1848, at the City of York; and they have defined the District of the Country Meeting of 1851 to be that comprising the Counties of Kent, Surrey, and Sussex.

The Council have decided to discontinue, after Michaelmas 1848, the appropriation of the sum of 200*l.* per annum to the Royal Veterinary College; and to appoint a Committee to recommend the best means of improving the Veterinary Art, in its special application to the Diseases of Cattle, Sheep, and Pigs, conformably with the eighth object indicated in the charter of the Society.

Professors Way and Ogston having conducted the important chemical investigation confided to them, on the inorganic substances which are found constantly to occur in the constitution of plants, their report of the results obtained during their research has been made known through the medium of the Society's Journal; and they are still actively engaged in the prosecution of their arduous task. The Council earnestly hope that those Members of the Society who have time and opportunity for the purpose will avail themselves of the striking facts adduced in that communication, and endeavour to ascertain, by actual trial, the practical value of the inorganic elements essentially required by cereal

crops to complete their growth under the most favourable circumstances.

The Council have the satisfaction of witnessing in every direction the beneficial effects resulting from the operations of the Society, in the increased energy with which all parties interested in agricultural pursuits concur in their efforts to advance, as the mainspring of national prosperity, a sound and scientific agricultural practice, combined with every available means by which the produce of the land may be most abundantly, and at the same time most economically, increased.

By order of the Council,

(Signed) JAMES HUDSON,

Secretary.

London, May 21, 1847.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account ending 31st Dec., 1846.

RECEIPTS.	£.	s.	d.
Balance in the hands of the Bankers, 1st July, 1846	2564	17	10
Ditto in the hands of the Secretary, 1st July, 1846	25	19	2
Dividends on Stock	110	8	8
Life Composition of Governor	40	0	0
Life Compositions of Members	269	0	0
Annual Subscriptions of Governors	232	0	0
Annual Subscriptions of Members	2760	6	0
Sale of Journal	167	4	6
Sale of Cottage Tracts	7	16	1
Receipts during the half-year on account of the Country Meetings	1620	10	11
Duke of Northumberland's Prizes	100	0	0
Local Prizes for Black-faced Sheep	35	0	0
Local Prizes for Cheviot Sheep	15	0	0
	£7948	3	2

(Signed) C. B. CHALLONER, THOMAS RAYMOND BARKER, } *Members of Finance Committee.*

PAYMENTS.	£.	s.	d.
Permanent Charges	278	12	6
Taxes and Rates	17	1	2
Establishment Charges	425	10	5
Postage and Carriage	44	18	0
Advertisements	5	4	0
Expenses of Journal	1328	1	2
Cottage Tracts	11	16	0
Prizes	1312	0	0
Duke of Northumberland's first Prize	50	0	0
Local Prizes for Black-faced Sheep	35	0	0
Local Prizes for Cheviot Sheep	15	0	0
Payments during the half-year on account of the Country Meetings	925	18	2
Analysis of Ashes of Plants	120	0	0
Subscriptions repaid	4	0	0
Bankers' Transfers	2	5	6
Miscellaneous Items	5	15	8
Balance in the hands of the Bankers, 31st December, 1846	3356	0	8
Ditto in the hands of the Secretary, 31st December, 1846	10	19	11
	£7948	3	2

Examined and audited 21st May, 1847.

(Signed) CHAS. TAWNEY, C. H. TURNER, THOMAS KNIGHT, } *Auditors on behalf of the Society.*

SPECIAL COUNTRY MEETING ACCOUNT: NEWCASTLE-UPON-TYNE, 1846.

Receipts.	£.	s.	d.
Subscription from Newcastle-upon-Tyne	1000	0	0
Dinner Tickets	594	0	0
Show-yard Receipts	2168	15	11
Sale of Catalogues	319	8	0
Sale of Badges	6	10	0
Excess of Payments over Receipts at the Newcastle Meeting, chargeable on the general Funds of the Society	747	0	3
	£4865	14	2

Payments.	£.	s.	d.
Dinner	553	10	0
Pavilion	640	0	0
Show-yard and Trial of Implements	2262	16	6
Police	187	13	3
Judges	364	0	0
Consulting-Engineer	63	0	0
Auctioneers	21	0	0
Printing	391	6	3
Stationery	18	15	5
Advertisements	270	2	6
Postage, Carriage, and Travelling Expences	53	0	6
Official Staff Charges	16	6	5
Lecture Expences	6	15	0
Agreements	5	18	4
Steel Die and Badges	4	4	0
Finance Clerks, Charwoman, and Doorkeeper	7	6	0
	£4865	14	2

(Signed) THOMAS AUSTEN, *Chairman of the Finance Committee.*

Essays and Reports.

I. AWARDS IN 1847.

To Thomas L. Colbeck, of East Denton Cottage, Newcastle-on-Tyne, the prize of Fifty Sovereigns, for the best Report on the Farming of Northumberland.

To Hugh Raynbird, of Hengrave, Bury St. Edmunds, the prize of Fifty Sovereigns, for the best Report on the Farming of Suffolk.

To Edward Roberts, jun., of Kingswood, Baldock, Herts, the prize of Twenty Sovereigns, for the best Essay on the Management of Wheat.

To Edward Jarman Lance, of Blackwater, Bagshot, the prize of Ten Sovereigns, offered by Major Curteis, M.P., one of the Governors of the Society, for the best account of the Hop Fly, and of the means for effecting its destruction or preventing its ravages.

To George Edmund Raynbird, of Hengrave, near Bury St. Edmunds, Suffolk, the prize of Twenty Sovereigns, for the best Essay on the Cultivation of Beet.

To Thomas Rowlandson, of St. Ann Street, Liverpool, the prize of Ten Sovereigns, for the best Statement on the Burning of Land for Manure.

To Robert Smith, of Burley-on-the-Hill, near Oakham, Rutlandshire, the prize of Twenty Sovereigns, for the best account of the Management of Sheep.

To John Algernon Clarke, of Long Sutton, Lincolnshire, the prize of Fifty Sovereigns, for the best Report of the Great Level of the Fens, including the Fens of South Lincolnshire.

II. PRIZES FOR 1848.

All Prizes of the Royal Agricultural Society of England are open to general competition.

I. Farming of the North Riding of Yorkshire.

Fifty Sovereigns will be given for the best Report on the Farming of the North Riding of Yorkshire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the agricultural management.
3. The improvements effected in the farming of the North Riding of Yorkshire since the Report of John Tuke in the year 1800.
4. The improvements still required in the Riding generally, as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

N.B. The writers of County Reports are requested, if possible, not to exceed the length of 40, or at most of 50 printed pages.

II. Farming of the East Riding of Yorkshire.

Fifty Sovereigns will be given for the best Report on the Farming of the East Riding of Yorkshire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the agricultural management.
3. The improvements effected in the farming of the East Riding of Yorkshire since the Report of H. E. Strickland in the year 1812.
4. The improvements still required in the Riding generally, as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

III. Farming of the West Riding of Yorkshire.

Fifty Sovereigns will be given for the best Report on the Farming of the West Riding of Yorkshire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the agricultural management.

3. The improvements effected in the farming of the West Riding of Yorkshire since the Report of Robert Brown in the year 1799.
4. The improvements still required in the Riding generally, as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

IV. Farming of Gloucestershire.

Fifty Sovereigns will be given for the best Report on the Farming of Gloucestershire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the agricultural management.
3. The improvements effected in the farming of Gloucestershire since the Report of Thomas Rudge in the year 1813.
4. The improvements still required in the county generally, as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

V. Farming of Devonshire.

Fifty Sovereigns will be given for the best Report on the Farming of Devonshire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the climate.
3. The course of cropping in the various parts of the county.
4. The management of the orchards.
5. The formation and management of the water-meadows, both in the valleys and on the hill-sides.
6. The improvements which have been made since the Report of Charles Vancouver in the year 1808, and those which are still required.

VI. Cattle.

Thirty Sovereigns will be given for the best account of the Management of Cattle.

Competitors will be required to describe—

1. The various breeds of cattle.
2. Their respective merits for milking, working, and feeding purposes.
3. The various modes of breeding and rearing; of working; and of fattening.

VII. Lime.

Twenty Sovereigns will be given for the best Report on the use of Lime as a Manure.

Competitors will be required to state—

1. The kinds of soil to which lime is usually applied.
2. The properties of the various kinds of lime.
3. The mode of application, and quantity to be applied.
4. Its effect on various crops.
5. How far high cultivation supersedes the use of lime.

VIII. Grass-Land.

Thirty Sovereigns will be given for the best Essay on the Management of Grass-Land.

Competitors will be required to attend to the following points:—

1. Actual practice in management of downs and inferior pastures, meadows, and grazing-ground.
2. Time of applying manure.
3. Haymaking.
4. Consumption of after-grass.
5. Eradication of weeds and coarse grasses.

IX. Hops.

Twenty Sovereigns will be given for the best account of the best mode of Managing Hops, in its various branches.

X. Farm-Horses.

Twenty Sovereigns will be given for the best Essay on the Management of Farm-Horses.

Competitors will be required to attend to the following points:—

1. The various breeds.
2. Breeding and rearing.
3. Keeping, whether in stables or in the open air.
4. Feeding, in different seasons.

XI. Hemp.

Twenty Sovereigns will be given for the best Essay on the Cultivation of Hemp.

Competitors will be required to state—

1. The soils suited to hemp.
2. Mode of culture.
3. Mode of obtaining the fibre.
4. Average amount and value of crop per acre.

XII. Pleuro-Pneumonia.

Fifty Sovereigns will be given for the best Report on the Pleuro-Pneumonia amongst Cattle.

Competitors will be required to state—

1. Mode of infection.
2. Precautions against infection.
3. Premonitory symptoms.
4. Treatment of the disease.

These Essays must be sent to the Secretary, at 12, *Hanover Square, London, on or before March* 1*st*, 1848.

Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources.
2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.
3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, and the subject of their Essay, and the number of that subject in the Prize list of the Society, shall be written.
4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.
5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of such Essays, not obtaining the Prize, as he may think likely to be useful for the Society's objects, with a view of consulting the writer confidentially as to his willingness to place such paper at the disposal of the Journal Committee.
6. The copyright of all Essays gaining prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.
7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.
8. In all reports of experiments the expenses shall be accurately detailed.
9. The imperial weights and measures only are those by which calculations are to be made.
10. No prize shall be given for any Essay which has been already in print.
11. Prizes may be taken in money or plate at the option of the successful candidate.
12. All Essays must be addressed to the Secretary, at the house of the Society.

General Meetings of 1847—8.

The General December Meeting, in London, on Saturday, December 11, 1847.

The General May Meeting, in London, on Monday, May 23, 1848.

The Annual Country Meeting, at York, in 1848.

Cottage Economy.—Mr. Main's article on Cottage Gardening, and Mr. Burke's compilation on Cottage Economy and Cookery, have each been reprinted from the Journal in a separate form, for cheap distribution. Either or both of these tracts may be obtained by members at the rate of 1*s.* per dozen copies, on their enclosing to the Secretary a Post-office money-order for the number required; at the same time stating the most eligible mode of conveyance by which the copies can be transmitted to their address. They are also sold to the public, at 2*d.* each, by the Society's Publisher, Mr. Murray, 50, Albemarle Street, London.

Volumes of the Journal.—The first Volume of the Journal consists of *four* parts, the second and third Volumes of *three* parts each (the second and third parts of the third Volume being comprised in a double number), and the fourth of *two* parts. The Journal is now published half-yearly, namely, the first half-volume for each year about the beginning of July, and the second about the end of December or beginning of January.

Subscriptions may be paid to the Secretary, in the most direct and satisfactory manner, by means of Post-office orders, to be obtained on application at any of the principal Post-offices throughout the kingdom. They are due in advance, for each year, on the 1st of January; and are in arrear if unpaid by the 1st of June ensuing. No Member is entitled to the Journal, or to any other privileges of the Society, whose subscription is in arrear.

Royal Agricultural Society of England.

1847—1848.

President.

THE EARL OF YARBOROUGH.

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STEVENSON, The Hon. ANDREW, Washington.

VAN DE WEYER, M. SYLVIAN, Belgian Minister.

WAY, JOHN THOMAS, Consulting-Chemist to the R.A.S. of E.

Meeting at Northampton.

PRINCIPAL DAY OF THE SHOW, JULY 22, 1847.

AWARD OF PRIZES.

CATTLE: I. *Short-Horns.*

JOHN PARKINSON, of Ley Fields, near Newark: the Prize of FIFTY SOVEREIGNS, for his 4 years 11 months and 3 days-old Short-horned Bull; bred by Thomas Lax, of Ravensworth, near Richmond, Yorkshire.

JOHN BOOTH, of Killerby, near Catterick: the Prize of TWENTY SOVEREIGNS, for his 2 years 9 months and 1 week-old Short-horned Bull; bred by himself.

WILLIAM SMITH, of West Rasen, near Market Rasen: the Prize of TWENTY SOVEREIGNS, for his 2 years and 6 months-old Short-horned Bull; bred by Thomas Lax, of Ravensworth, near Richmond, Yorkshire.

WILLIAM LINTON, of Sheriff Hutton, near York: the Prize of TEN SOVEREIGNS, for his 1 year and 7 months-old Short-horned Bull; bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton: the Prize of TWENTY SOVEREIGNS, for his 3 years 2 months and 3 weeks-old Short-horned Cow; bred by himself.

MARQUIS OF EXETER, of Burghley House, near Stamford: the Prize of TEN SOVEREIGNS, for his 7 years and 3 months-old Short-horned Cow; bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton: the Prize of FIFTEEN SOVEREIGNS, for his 2 years 3 months and 3 weeks-old Short-horned in-calf Heifer; bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton: the Prize of TEN SOVEREIGNS, for his 1 year 4 months and 2 weeks-old Short-horned Yearling Heifer; bred by himself.

CATTLE: II. *Herefords.*

SAMUEL ASTON, of Lynch Court, near Leominster: the Prize of FIFTY SOVEREIGNS, for his 3 years and 6 months-old Hereford Bull; bred by himself.

JAMES CORBETT, of The Sheriffs, Lyonshall, near Leominster: the Prize of TWENTY SOVEREIGNS, for his 4 years 8 months and 13 days-old Hereford Bull; bred by himself.

GEORGE PITT, of Wellington, near Hereford: the Prize of TWENTY SOVEREIGNS, for his 1 year and 8 months-old Hereford Bull; bred by himself.

JOHN NELSON CARPENTER, of Eardisland, near Leominster: the Prize of TEN SOVEREIGNS, for his 1 year and 11 months-old Hereford Bull; bred by himself.

WILLIAM ALLATT, of Glinton, near Peterborough: the Prize of TWENTY SOVEREIGNS, for his 5 years and 2 months-old Hereford in-calf Cow; bred by Richard Whiteman, of Ashford, Herefordshire.

SAMUEL ASTON, of Lynch Court, near Leominster: the Prize of TEN SOVEREIGNS, for his 10 years and 4 months-old Hereford in-calf Cow; bred by the Rev. J. R. Smythies, of Grey Friars, Colchester.

EDWARD WILLIAMS, of Lowes Court, near Hay: the Prize of FIFTEEN SOVEREIGNS, for his 2 years 10 months and 6 days-old Hereford in-calf Heifer; bred by John Nelson Carpenter, of Eardisland, near Leominster.

SAMUEL ASTON, of Lynch Court, near Leominster: the Prize of TEN SOVEREIGNS, for his 1 year and 10 months-old Hereford Yearling Heifer; bred by himself.

CATTLE: III. *Devons.*

THOMAS BOND, of Bishop's-Lydeard, near Taunton: the Prize of FIFTY SOVEREIGNS, for his 3 years and 6 months-old Devon Bull; bred by Richard Merson, of North Molton, Devon.

DUKE OF MANCHESTER, of Kimbolton Castle, Hunts: the Prize of TWENTY SOVEREIGNS, for his 2 years and 11 months-old Devon Bull; bred by himself.

DUKE OF MANCHESTER, of Kimbolton Castle, Hunts: the Prize of TWENTY SOVEREIGNS, for his 8 years and 3 months-old pure Devon Cow; bred by the late Duke of Norfolk, at Fornham Abbey, near Bury St. Edmunds.

GEORGE TURNER, of Barton, near Exeter: the Prize of TEN SOVEREIGNS, for his 9 years-old Pure Devon Cow; bred by John Moggeridge, of Molland, Devon,

Edward Pope, of Mapperton, near Beaminster: the Prize of Fifteen Sovereigns, for his 2 years and 4 months-old Pure Devon in-calf Heifer; bred by himself.

James Hole, of Knowle House, near Dunster: the Prize of Ten Sovereigns, for his 1 year and 4 months-old Devon Heifer; bred by himself.

Cattle: IV. *Any Breed* (not qualified to compete in the foregoing Classes).

William Umbers, of Wappenbury, near Leamington: the Prize of Fifteen Sovereigns, for his 6 years and 4 months-old Pure Long-horned in-milk Cow; bred by himself.

Duke of Buckingham and Chandos, of Stowe, near Buckingham: the Prize of Ten Sovereigns, for his 2 years 11 months and 2 days-old Pure Long-horned in-calf Heifer; bred by himself.

Duke of Buckingham and Chandos, of Stowe, near Buckingham: the Prize of Ten Sovereigns, for his 1 year 8 months and 3 days-old Pure Long-horned Heifer; bred by himself.

Horses.

Frederick Thomas Bryan, of Knossington, near Oakham: the Prize of Forty Sovereigns, for his 4 years-old Cart Stallion; bred by Richard Brown, of Elsworth, Cambridgeshire.

Duke of Manchester, of Kimbolton Castle, Hunts: the Prize of Fifteen Sovereigns, for his 6 years-old Cart Stallion of the Suffolk Breed; bred by Thomas Catlin, of Butley Abbey, near Woodbridge.

Viscount Hill, of Hawkstone, near Shrewsbury: the Prize of Fifteen Sovereigns, for his 2 years-old Cart Stallion of the Suffolk Breed; bred by himself.

George Townshend, of Sapcote, near Hinckley: the Prize of Twenty Sovereigns, for his Cart Mare and Foal; the sire of the Foal belonged to John Hipwell, of Swinford, near Lutterworth.

Anthony Chibnall, of Bromham, near Bedford: the Prize of Ten Sovereigns, for his Cart Mare and Foal; the sire of the Foal belonged to himself.

William Barnes, of Byfield, near Northampton: the Prize of Ten Sovereigns, for his 2 years-old Filly; bred by himself.

Sheep: I. *Leicesters.*

Thomas Edward Pawlett, of Beeston, near Biggleswade: the Prize of Forty Sovereigns, for his 16 months-old Leicester Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Biggleswade: the Prize of Fifteen Sovereigns, for his 16 months-old Leicester Ram; bred by himself.

Robert Smith, of Burley-on-the-Hill, near Oakham: the Prize of Thirty Sovereigns, for his 28 months-old Leicester Ram; bred by himself.

William Sanday, of Holme Pierrepoint, Nottingham: the Prize of Twenty Sovereigns, for his pen of five 16 months-old Leicester Shearling Ewes; bred by himself.

Robert Smith, of Burley-on-the-Hill, near Oakham: the Prize of Ten Sovereigns, for his pen of five 16 months-old Leicester Shearling Ewes; bred by himself.

Sheep: II. *Southdowns.*

Jonas Webb, of Babraham, near Cambridge: the Prize of Forty Sovereigns, for his 16 months-old Southdown Ram; bred by himself.

Jonas Webb, of Babraham, near Cambridge: the Prize of Fifteen Sovereigns, for his 16 months-old Southdown Ram; bred by himself.

John Harris, of Hinton, near Abingdon: the Prize of Thirty Sovereigns, for his 40 months-old Pure Southdown Ram; bred by himself.

John Harris, of Hinton, near Abingdon: the Prize of Fifteen Sovereigns, for his 40 months-old Pure Southdown Ram; bred by himself.

Duke of Manchester, of Kimbolton Castle, Hunts: the Prize of Twenty Sovereigns, for his pen of five 16 months-old Southdown Shearling Ewes; bred by himself.

David Barclay, M.P., of Eastwick Park, Leatherhead: the Prize of Ten Sovereigns, for his pen of five 16 months-old Pure Southdown Shearling Ewes; bred by himself.

Sheep: III. *Long-Wools.*

Charles Large, of Broadwell, near Lechlade: the Prize of Forty Sovereigns, for his 16 months-old New Oxfordshire Long-woolled Ram; bred by himself.

Christopher Faulkner Allen Faulkner, of Bury Barns, near Burford: the Prize of Fifteen Sovereigns, for his 15 months-old Improved Oxfordshire Long-woolled Ram; bred by himself.

Charles Large, of Broadwell, near Lechlade: the Prize of Thirty Sovereigns, for his 40 months-old New Oxfordshire Long-woolled Ram; bred by himself.

Edward Handy, of Sevenhampton, near Andoversford: the Prize of Fifteen Sovereigns, for his 40 months-old Improved Cotswold Long-woolled Ram; bred by himself.

Charles Large, of Broadwell, near Lechlade: the Prize of Twenty Sovereigns, for his pen of five 16 months-old New Oxfordshire Long-woolled Shearling Ewes; bred by himself.

Charles Large, of Broadwell, near Lechlade: the Prize of Ten Sovereigns, for his pen of five 16 months-old New Oxfordshire Long-woolled Shearling Ewes; bred by himself.

Pigs.

Earl Spencer, of Althorp Park, near Northampton: the Prize of Fifteen Sovereigns, for his 2 years-old Berkshire Boar of a large breed; bred by himself.

Moses Cartwright, of Stanton Hill, near Burton-upon-Trent: the Prize of Five Sovereigns, for his 1 year and 2 months-old Boar of a large breed; bred by himself.

William Fisher Hobbs, of Boxted Lodge, Colchester: the Prize of Fifteen Sovereigns, for his 10 months 3 weeks and 1 day-old Improved Essex Boar of a small breed; bred by himself.

Moses Cartwright, of Stanton Hill, near Burton-upon-Trent: the Prize of Five Sovereigns, for his 9 months-old Boar of a small breed; bred by himself.

Moses Cartwright, of Stanton Hill, near Burton-upon-Trent: the Prize of Ten Sovereigns, for his 1 year and 7 months-old Tamworth Breeding Sow of a large breed; bred by himself.

William Fisher Hobbs, of Boxted Lodge, near Colchester: the Prize of Ten Sovereigns, for his 7 months 3 weeks and 5 days-old Improved Essex Breeding Sow of a small breed; bred by himself.

Earl of Radnor, of Coleshill, near Faringdon: the Prize of Ten Sovereigns, for his pen of Three under 52 weeks-old Coleshill Breeding Sow Pigs of a large breed of the same litter; bred by himself.

William Fisher Hobbs, of Boxted Lodge, near Colchester: the Prize of Ten Sovereigns for his pen of Three 7 months 3 weeks and 4 days-old Improved Essex Breeding Sow Pigs of a small breed of the same litter; bred by himself.

Cheese.

William Norman, of Ashow, near Kenilworth: the Prize of Ten Sovereigns, for his sample of One Hundred Weight of Warwickshire Cheese; made by himself.

IMPLEMENTS.

William Busby, of Newton-le-Willows, near Bedale, for the best Plough adapted to heavy land . . . Ten Sovereigns.

John Howard, of Bedford, for the best Plough adapted to light land . . . . Ten Sovereigns.

Richard Garrett, of Leiston Works, near Saxmundham, for the best Drill for general purposes . . . Fifteen Sovereigns.

Richard Garrett, of Leiston Works, near Saxmundham, for the best Turnip Drill on the flat . . . . Ten Sovereigns.

Richard Garrett, of Leiston Works, near Saxmundham, for the best Turnip Drill on the ridge . . . . Ten Sovereigns.

John Wood Sharman, of Wellingborough, William Proctor Stanley, of Peterborough, and Thomas Johnson, of Leicester, for the best Scarifier . . . . . . Ten Sovereigns.

John Cornes, of Barbridge, near Nantwich, for the best Chaff Cutter . . . . Ten Sovereigns.

Sanders and Williams, of Bedford, and Samuel Taylor, of Cotton End, Bedford, for the best machine for making Draining Tiles or Pipes . . . . . Twenty-five Sovereigns.

*Sanders and Williams, of Bedford, and Samuel Taylor, of Cotton End, Bedford, for the best Harrow . . Five Sovereigns.

Richard Hornsby, of Spittlegate, Grantham, for the best Drill Presser, depositing manure and seed . . . Ten Sovereigns.

Richard Robinson, of Lisburn, county Antrim, for the best Churn . . . . . . Five Sovereigns.

Herbert George James, of 44, Fish Street Hill, London, for the best Weighing Machine for live cattle and farm produce generally . . . . Ten Sovereigns.

Richard Robinson, of Lisburn, county Antrim, Ireland, for the best and most economical Steaming Apparatus for general purposes . . . . Ten Sovereigns.

George Kilby, of Queniborough, near Leicester, for the best Skim or Paring Plough . . . . . Five Sovereigns.

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* This prize has been suspended by the Council, in order to allow a trial to be made, at the request of Mr. John Howard, of Bedford, under the Patent-Right Clause, in the report of the Council to the General Meeting on the 22nd May, 1846.

John Read (Exors. of the late), of 35, Regent Circus, London, for the best Subsoil Pulverizer . . . Ten Sovereigns.

James Wilmot Newberry, of Hook Norton, near Chipping Norton, for the best Horse Seed-Dibbler . . Fifteen Sovereigns.

John Ferrabee, of Phœnix Iron Works, near Stroud, for the best Linseed Crusher . . . . . Five Sovereigns.

Richard Stratton, of Bristol, for the best One Horse Cart Ten Sovereigns.

Richard Garrett, of Leiston Works, near Saxmundham, for the best Threshing Machine, applicable to Horse or Steam Power Twenty Sovereigns.

Henry Clayton, of 21, Upper Park Place, Dorset Square, London, for the best Draining Tools for Clay Land Five Sovereigns.

Mapplebeck and Lowe, of Birmingham, for the best Draining Tools for Friable Land . . . . . Five Sovereigns.

Mapplebeck and Lowe, of Birmingham, for the best Set of Tools for General Draining . . . . . Five Sovereigns.

William Cambridge, of Market Lavington, near Devizes, for the best Steam Engine applicable to Threshing and other Agricultural purposes . . . . . . Fifty Sovereigns.

Joshua Cooch, of Harleston, near Northampton, for the best Corn-Dressing Machine . . . . Fifteen Sovereigns.

William Crosskill, of the Beverley Iron Works, Beverley, for the best Broad-cast Manure Distributor . . Ten Sovereigns.

James Smyth, of Peasenhall, near Yoxford, for his Clover-Seed and Rye-Grass Barrow . . . . . Silver Medal.

John Read (Exors. of the late), of 35, Regent Circus, Piccadilly, London, for his Agricultural Fire Engine . Silver Medal.

Joseph Cooke Grant, of Stamford, for his Patent Lever Horse Rake Silver Medal.

Mapplebeck and Lowe, of Birmingham, for their Patent Turnip Cutter . . . . Silver Medal.

Wedlake and Thompson, of Union Foundry, Hornchurch, Essex, for their American Oil-Cake Breaker . . Silver Medal.

William Newzam Nicholson, of Newark-on-Trent, Notts., for his powerful Oil-Cake Breaker, with adjustment for the Parallel Rollers . . . . Silver Medal.

Richard Garrett, of Leiston Works, near Saxmundham, for his Patent Horse Hoe . . . . . Silver Medal.

Commendations.

CAPEL HANBURY LEIGH, of Pontypool Park, near Pontypool: for his 4 years and 5 months-old pure Short-Horned Bull; bred by himself.

The MARQUIS of NORTHAMPTON, of Castle Ashby, near Northampton: for his 2 years 6 months and 23 days-old Durham Bull; bred by John Beasley, of Chapel Brampton, near Northampton.

*RICHARD BOOTH, of Warlaby, near Northallerton: for his 1 year 2 months and 2 weeks-old Short-Horned Bull; bred by himself.

*ALEXANDER BANNERMAN, of South Cottage, Chorley: for his 7 years and 18 days-old Short-Horned Cow; bred by John Booth, of Killerby, near Catterick.

*JOHN BOOTH, of Killerby, near Catterick, for his 4 years 2 months and 3 weeks-old Short-Horned Cow; bred by himself.

*RICHARD BOOTH, of Warlaby, near Northallerton: for his 3 years 2 months and 3 weeks-old Short-Horned Cow; bred by himself.

*WILLIAM DE CAPELL BROOKE, of Market Harborough: for his 6 years 17 weeks and 4 days-old Short-Horned Cow; bred by himself.

*The DUKE of BUCCLEUCH and QUEENSBERRY, of Boughton House, near Kettering: for his 5 years and 8 months-old Short-Horned Cow; bred by himself.

*The DUKE of DEVONSHIRE, of Chatsworth, near Chesterfield, for his 5 years and 5 months-old Short-Horned Cow: bred by Henry Watson, of Walkeringham, near Bawtry.

*The MARQUIS of EXETER, of Burghley House, near Stamford: for his 7 years and 3 months-old Short-Horned Cow; bred by himself.

*JOHN HALL, of Wiseton, near Bawtry: for his 7 years and 8 months-old Short-Horned Cow; bred by the late Earl Spencer, of Wiseton, near Bawtry.

*SIR CHARLES KNIGHTLEY, of Fawsley, near Daventry: for his 7 years and 3 months-old Short-Horned Cow; bred by himself.

*W. D. MANNING, of Rothersthorpe, near Northampton: for his 7 years 2 weeks and 5 days-old Short-Horned Durham Cow; bred by himself.

*The MARQUIS of NORTHAMPTON, of Castle Ashby, near Northampton: for his 6 years and 2 months-old Durham Cow; bred by the Rev. John Sutton, of ———.

*FREDERICK SARTONS, of Rushden Hall, near Wellingborough: for his 9 years and 6 months-old Short-Horned Cow; bred by John Musson, of ———.

*LORD SOUTHAMPTON, of Whittlebury, near Towcester: for his 9 years and 10 months-old Short-Horned Cow; bred by John Beasley, of Chapel Brampton, near Northampton.

*LORD SOUTHAMPTON, of Whittlebury, near Towcester: for his 6 years and 10 months-old Short-Horned Cow; bred by Charles Stokes, of Kingston, near Kegworth.

*LORD SOUTHAMPTON, of Whittlebury, near Towcester; for his 5 years and 4 months-old Short-Horned Cow; bred by W. D. Manning, of Rothersthorpe, near Northampton.

RICHARD BOOTH, of Warlaby, near Northallerton: for his 2 years 3 months and 3 weeks-old Short-Horned In-Calf Heifer; bred by himself.

JOHN BOWERS, of Braunston, near Daventry: for his 2 years and 11 months-old Short-horned In-Calf Heifer; bred by himself.

The DUKE of BUCCLEUCH and QUEENSBERRY, of Boughton House, near Kettering: for his 2 years and 4 months-old Short-Horned Durham In-Calf Heifer; bred by himself.

LORD FEVERSHAM, of Duncombe Park, near Helmsley: for his 2 years and 3 months-old Short-Horned In-Calf Heifer; bred by himself.

JOHN FLAVELL, of Harleston, near Northampton: for his 2 years and 3 months-old Short-Horned In-Calf Heifer; bred by Thomas Gross, of Harleston, near Northampton.

John Flavell, of Harleston, near Northampton: for his 2 years and 2 months-old Short-Horned In-Calf Heifer; bred by himself.

Thomas Ivens, of Lutterworth: for his 2 years and 4 months-old Short-Horned In-Calf Heifer; bred by the late James Hill, of Broughton Astley.

The Marquis of Northampton, of Castle Ashby, near Northampton: for his 2 years and 2 months-old Durham In-Calf Heifer; bred by himself.

Charles Barnett, of Stratton Park, near Biggleswade: for his 1 year and 7 months-old Short-Horned Yearling Heifer; bred by himself.

Charles Barnett, of Stratton Park, near Biggleswade: for his 1 year and 7 months-old Short-Horned Yearling Heifer; bred by himself.

*Samuel Bennett, of Bickerings Park, near Woburn, Beds: for his 1 year and 6 months old Short-Horned Yearling Heifer; bred by Charles Stokes, of Kingston, near Kegworth.

Richard Booth, of Warlaby, near Northallerton: for his 1 year 4 months and 2 weeks-old Short-Horned Yearling Heifer; bred by himself.

The Duke of Devonshire, of Chatsworth, near Chesterfield: for his 1 year and 8 months-old Short-Horned Yearling Heifer; bred by himself.

The Marquis of Exeter, of Burghley House, near Stamford: for his 1 year and 7 months-old Short-Horned Yearling Heifer; bred by himself.

Lord Feversham, of Duncombe Park, near Helmsley: for his 1 year and 11 months-old Short-Horned Yearling Heifer; bred by himself.

John Forrest, of Stretton, near Warrington: for his 1 year 3 months and 23 days-old Short-Horned Yearling Heifer; bred by himself.

John Hall, of Wiseton, near Bawtry: for his 1 year and 8 months-old Short-Horned Yearling Heifer; bred by himself.

John Hall, of Wiseton, near Bawtry: for his 1 year and 5 months-old Short-Horned Yearling Heifer; bred by himself.

Viscount Hill, of Hawkstone, near Shrewsbury: for his 1 year 5 months and 20 days-old Short-Horned Yearling Heifer; bred by himself.

Sir Charles Knightley, of Fawsley, near Daventry: for his 1 year and 2 weeks-old Short-Horned Yearling Heifer; bred by himself.

The Marquis of Northampton, of Castle Ashby, near Northampton: for his 1 year 9 months and 13 days-old Durham Yearling Heifer; bred by the Rev. John Sutton.

Edward William Smythe Owen, of Condover Hall, near Shrewsbury: for his 1 year and 8 months old Short-Horned Yearling Heifer; bred by himself.

*John Parkinson, of Ley Fields, near Newark: for his 1 year 4 months and 3 days-old Short-Horned Yearling Heifer; bred by himself.

John Parkinson, of Ley Fields, near Newark: for his 1 year 4 months and 1 day-old Short-Horned Yearling Heifer; bred by himself.

*John Nelson Carpenter, of Eardisland, near Leominster: for his 11 years-old Hereford Bull; bred by the late Thomas Jefferies, of the Grove, near Pembridge.

*Joseph Lush, of Kilmington, near Wincanton: for his 3 years and 5 months-old Hereford Bull; bred by himself.

*Edward Williams, of Lowes Court, near Hay: for his 2 years 9 months and 5 days-old Hereford In-calf Heifer; bred by John Nelson Carpenter, of Eardisland, near Leominster.

*Thomas White Fouracre, of Durston, near Taunton: for his 3 years and 10 months-old Devon Bull; bred by himself.

*George Turner, of Barton, near Exeter: for his 6 years and 3 months-old pure Devon Cow; bred by James Quartly, of Molland, near Southmolton.

*Darwin Galton, of Edstone, near Stratford-on-Avon: for his aged Cart Stallion of the Cleveland breed; bred by Thomas Moss, of Scargil, Durham.

*James Howard, of Plum Park, near Towcester: for his 7 years-old Cart Stallion: bred by John Edwards, of Blakesley.

Samuel and Robert Spencer, of Flecknoe, near Daventry: for their 6 years-old Cart Stallion; bred by Richard Smith, of Draycote, near Dunchurch.

Henry Eddison, of Gateford, near Worksop: for his 2 years-old Cart Stallion; bred by himself.

George Townshend, of Sapcote, near Hinckley: for his 2 years-old Cart Stallion of the Leicestershire breed; bred by himself.

*Edward Spencer Trower, of Watton House, near Ware: for his 2 years-old Cart Stallion, mostly of the Suffolk breed; bred by himself.

*Alfred Lee, of Haddenham, near Aylesbury; for his Cart Mare and Foal; the sire of the foal belonged to Richard Harding, of Finmere, Oxon.

Lord St. John, of Melchbourne, near Higham Ferrers: for his Cart Mare and Foal; the Mare was bred by himself; the sire of the foal belonged to himself.

Samuel Bennett, of Bickerings Park, near Woburn, Beds: for his 16 months-old pure Leicester Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Biggleswade: for his 16 months-old Leicester Ram; bred by himself.

Samuel Bennett, of Bickerings Park, near Woburn, Beds: for his 64 months-old pure Leicester Ram; bred by Robert Smith, of Burley-on-the-Hill, near Oakham.

Samuel Bennett, of Bickerings Park, near Woburn, Beds: for his 40 months-old pure Leicester Ram; bred by himself.

Thomas Freestone, of Irthlingborough, near Higham Ferrers: for his 52 months-old Leicester Ram; bred by the late Thomas Freestone.

Richard Hewitt, of Dodford, near Weedon: for his 40 months-old Leicester Ram; bred by himself.

Richard Hewitt, of Dodford, near Weedon: for his 52 months-old Leicester Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Biggleswade: for his 40 months-old Leicester Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Biggleswade: for his 28 months-old Leicester Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Biggleswade: for his 28 months-old Leicester Ram; bred by himself.

Samuel Wallis, of Barton Seagrave, near Kettering: for his 53 months-old new Leicester Ram; bred by John Manning, of Orlingbury.

*Charles Large, of Broadwell, near Lechlade: for his 16 months-old new Oxfordshire Long-woolled Ram; bred by himself.

Charles Large, of Broadwell, near Lechlade: for his 16 months-old new Oxfordshire Long-woolled Ram; bred by himself.

Edward Handy, of Sevenhampton, near Andoversford: for his 40 months-old improved Cotswold Long-woolled Ram; bred by himself.

*Viscount Hill, of Hawkstone, near Shrewsbury: for his 11 months and 19 days-old Hawkstone Boar, of a small breed; bred by himself.

*William Fisher Hobbs, of Boxted Lodge, near Colchester: for his 7 months 3 weeks and 4 days-old improved Essex Boar, of a small breed; bred by himself.

*William Fisher Hobbs, of Boxted Lodge, near Colchester: for his 7 months 3 weeks and 4 days-old improved Essex Boar, of a small breed; bred by himself.

*Philip Pusey, M.P., of Pusey, near Faringdon: for his 2 years and 7 months-old Berkshire Sow, of a large breed; bred by himself.

Moses Cartwright, of Stanton Hill, near Burton-on-Trent: for his 9 months-old Sow, of a small breed; bred by himself.

Viscount Hill, of Hawkstone, near Shrewsbury: for his 11 months and 19 days-old Hawkstone Sow, of a small breed; bred by himself.

William Fisher Hobbs, of Boxted Lodge, near Colchester: for his 1 year and 8 months-old improved Essex Sow, of a small breed; bred by himself.

Philip Pusey, M.P., of Pusey, near Faringdon, for his Pen of Three 33 weeks-old Berkshire Breeding Sow Pigs; bred by himself.

W. D. Manning, of Rothersthorpe, near Northampton: for his 4 years and 9 months-old Short-horned Cow; bred by himself.

*William Sherley, of Staines, Middlesex: for his 10 years-old Grey Stallion; bred by John Brears, of Green Hammerton, near Wetherby.

*Charles Large, of Broadwell, near Lechlade: for his 8 years and 4-months old new Oxfordshire Long-woolled Ewe; bred by himself.

[These Commendations are arranged in the order of the numbers of the Certificates to which they refer. The mark (*) signifies "highly commended;" the omission of it, "commended;" by the Judges.]

General Meetings of 1847—8.

The General December Meeting, in London, on Saturday, December 11, 1847.

The General May Meeting, in London, on Monday, May 23, 1848.

The Annual Country Meeting, at York, in 1848.

Cottage Economy.—Mr. Main's article on Cottage Gardening, and Mr. Burke's compilation on Cottage Economy and Cookery, have each been reprinted from the Journal in a separate form, for cheap distribution. Either or both of these tracts may be obtained by members at the rate of 1*s.* per dozen copies, on their enclosing to the Secretary a Post-office money-order for the number required; at the same time stating the most eligible mode of conveyance by which the copies can be transmitted to their address. They are also sold to the public, at 2*d.* each, by the Society's Publisher, Mr. Murray, 50, Albemarle Street, London.

Volumes of the Journal.—The first Volume of the Journal consists of *four* parts, the second and third Volumes of *three* parts each (the second and third parts of the third Volume being comprised in a double number), and the fourth of *two* parts. The Journal is now published half-yearly, namely, the first half-volume for each year about the beginning of July, and the second about the end of December or beginning of January.

Subscriptions may be paid to the Secretary, in the most direct and satisfactory manner, either at the office of the Society, No. 12, Hanover Square, London, between the hours of ten and four, or by means of Post-office orders, to be obtained on application at any of the principal Post-offices throughout the kingdom, and made payable at the General Post-office, London; but any Cheque on a London Banker, or other House of Business in London, will be equally available. They are due in advance, for each year, on the 1st of January; and are in arrear if unpaid by the 1st of June ensuing. No Member is entitled to the Journal, or to any other privileges of the Society, whose subscription is in arrear.

Royal Agricultural Society of England,

COUNTRY MEETING AT YORK IN THE YEAR 1848.

PRIZES AND REGULATIONS FOR AGRICULTURAL IMPLEMENTS:

Subject to such Conditions as may hereafter be decided upon by the Council.

The Prizes are open to general competition; Members having the privilege of a free entry; and Non-subscribers allowed to compete on the payment of a fee of 5*s*. on each certificate. There will be no sale by auction in the Show Yard.

Forms of Certificate to be procured on application to the Secretary, 12, *Hanover Square, London. All Certificates for the entry of Implements, &c., and the space required for their exhibition, must be returned, filled up, to the Secretary, on or before the First of May,* 1848*; the Council having decided, that in no case whatever shall any such Certificate for Implements be received after that date.*

Prizes.

For the Plough best adapted to heavy land . .	Ten Sovereigns.
For the Plough best adapted to light land . .	Ten Sovereigns.
For the best Drill for general purposes, which shall possess the most approved method of distributing Compost or other Manures in a moist or dry state, quantity being especially considered	Fifteen Sovereigns.

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

For the best Turnip Drill on the flat, which shall possess the most approved method of Distributing Compost or other manures in a moist or dry state, quantity being especially considered	Ten Sovereigns.

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

For the best Turnip Drill on the ridge, which shall possess the most approved method of distributing Compost or other Manures in a moist or dry state, quantity being especially considered	Ten Sovereigns.

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

For the best Hand Drilling Machine for Depositing Carrot, Mangold-wurzel, or Turnip Seed .	Five Sovereigns.
For the best Scarifier or Grubber	Ten Sovereigns.
For the best Machine for making Draining Tiles or Pipes for Agricultural Purposes. Specimens of the Tiles or Pipes to be shown in the Yard: the price at which they have been sold to be taken into consideration, and proof of the working of the Machine to be given to the satisfaction of the Judges	Twenty Sovereigns.
For the best Harrow	Five Sovereigns.
For the best and most economical Steaming Apparatus for general purposes	Ten Sovereigns.
For the best Skim or Paring Plough	Five Sovereigns.
For the best Horse-Seed-Dibbler	Ten Sovereigns.
For the best One-Horse Cart	Five Sovereigns.
For the best Waggon	Ten Sovereigns.
For the best Threshing-Machine applicable to Horse or Steam-power	Twenty Sovereigns.
For the best portable or fixed Steam Engine, applicable to Threshing, or other Agricultural purposes	Fifty Sovereigns.
For the best Corn-dressing Machine	Ten Sovereigns.
For the best Gorse-Bruiser	Five Sovereigns.
For the best Implement for distributing Pulverized Manures broadcast	Ten Sovereigns.
For the best Grinding Mill for breaking Agricultural Produce into fine Meal	Fifteen Sovereigns.
For the best and cheapest Grate or Stove for Cottages, combining safety and economy of fuel with effectual warmth and facility for cooking.	Five Sovereigns.
Miscellaneous Awards . . .	Not exceeding Twenty Silver Medals.

For the Invention of any New Implement, such sum as the Council may think proper to award.

GENERAL REGULATIONS FOR THE EXHIBITION OF IMPLEMENTS.

Certificates.

1. The necessary printed forms of certificates may be obtained from the Secretary, at No. 12, Hanover Square, London, by persons who are desirous of exhibiting implements, &c.

2. No implement will be admitted for exhibition unless the necessary certificates, filled in on the printed form prescribed, complete, and signed by the exhibitor (or his agent), in the manner directed have been delivered to the Secretary, or sent (postage free), directed to him so as to reach No. 12, Hanover Square, on or before the FIRST OF MAY, 1848 (any additional particulars or specifications of such implements need not be delivered until the 1st of June, 1848). For the satisfaction of Exhibitors, the Secretary will take an early opportunity of acknowledging the due receipt and registration of such certificates.

3. A description of each article intended to be shown must be written on one side only of the certificate; it must state the name and address (when they are known) of the inventor, the improver, and the manufacturer: it must also detail the improvements (if any), peculiarities, &c., of each implement.

4. The certificate must state the space each exhibitor will probably require (the sheds being 20 feet wide), in order that the Director or Stewards may apportion the standing-room among the various parties who make application.

5. The certificate must state the lowest selling price of each article; and each Exhibitor shall be bound to execute all orders given him in the Show Yard, at the price stated in his certificate.

6. If an article is intended to compete for the prize offered for any new agricultural implement, it must be entered as such in the certificate.

7. If a prize or medal has been awarded at a previous meeting of the Society, to any implement which is entered for exhibition at York, the certificate must state whether it was a prize or medal, or both, and the date at which it was awarded; if a prize, the amount must be stated.

8. If any improvement has been made in the implement subsequently to that award, a description and drawing of the improvement must accompany the certificate.

9. Persons who intend to send their own horses and driver to work in the field, must declare, in the certificate, their intention of doing so; otherwise they will not be entitled to the remuneration stipulated in Rule 25.

10. In order to check the entry of Implements which are not intended to be exhibited, a fine of 5*s.* on Implements under 10*l.* in value, and a fine of 10*s.* on Implements of 10*l.* and upwards in value, will be charged on each Implement entered and not exhibited, unless a Certificate shall be sent to the Secretary on or before the day of Exhibition, that the non-exhibition is caused by unavoidable accident.

Arrival of Implements, &c.

11. All implements, &c., entered for exhibition, must be brought to the Show-yard before nine o'clock on the evening of Thursday in the week preceding that of the Show.

12. No implement, &c., will be admitted into the Yard for exhibition, unless it has been described as a separate article, in the form prepared for that purpose, attached to the certificate delivered to the Secretary.

13. A ticket, bearing the number corresponding with the certificate, must be attached to some conspicuous part of each article, before it is brought to the gate.

14. The admission-order, which will be sent for articles properly entered, must be delivered to the gate-keeper of the Yard by the person who brings the articles for admission.

15. No implement, having upon it paint or varnish that is wet, will be allowed to enter the Yard.

Arrangement of Implements.

16. All implements must be unpacked and arranged in each stand, by the exhibitor, according to their numbers, and in the same direction as the numbers of the different stands run, consecutively. As no day has been set apart this year for the arrangement of implements, exhibitors are requested to have them arranged by nine o'clock in the evening of Thursday, in the week preceding that of the Show, as the Judges will commence their inspection early on the following morning. All Implements, &c., that are not unpacked by that hour, will be removed from the Yard.

17. No implement will be allowed to be painted or varnished after it has entered the Yard.

Trial.

18. All implements admitted to the exhibition will be liable, upon the recommendation of the Judges, to be proved by actual trial.

19. Ample private trial will be given to such implements as the Judges shall select, and at the time and place appointed by the Stewards.

20. A public exhibition of "implements at work" will take place; but of such implements only as may be selected by the Judges, or of such as have gained prizes at previous meetings of the Society.

21. No person will be permitted to remove any implement from the Yard to the Field, unless by the express orders of the Director or Stewards, upon the recommendation of the Judges.

22. Exhibitors are requested to be in attendance during the trials, and in the implement-yard, while the Judges are inspecting the implements, in case any explanation may be required from them.

23. No implement will be allowed to commence work in the field, unless by the express orders of the Judges or Stewards.

24. Notice of the nature of the soil, upon which the trials are to take place, will be given to the exhibitors, by the Secretary.

25. An option of sending a pair of horses and a man is given to the exhibitors of implements, if they declare such intention at the time of returning the certificate: the Society paying to the man 5*s.* for each day he works at the trial of implements, and 2*l.* for the pair of horses for the three days, to be employed primarily at the exhibition of the master's implements; but should these not be in work, to be under the directions of the Stewards.

26. Chaff-cutters, corn-crushers, and other small implements, will be removed, for trial, into the space attached to the implement-yard, into which space the Judges of implements, and the exhibitor, during the trial of his implement, will alone be admitted.

27. Hay, straw, turnips, &c., may be brought with the implements for the purpose of being used in the trial of those implements.

Consulting-Engineer.

28. The Consulting-Engineer will not act as one of the Judges of Implements, but only as mechanical referee, in case the Judges may deem it necessary to call in his aid.

29. The Consulting-Engineer will be in attendance in the Yard, and during the trials, to examine the Implements.

Departure of Implements, &c. (After the Show.)

30. No implements, excepting those selected for trial, can be removed from the Yard, until 6 o'clock on the evening of Thursday, in the week of the Show.

31. The "Delivery Order," filled up and signed by the exhibitor or his agent, must be delivered to the gate-keeper: no implement can be removed without it.

General and Miscellaneous Regulations.

32. Non-Subscribers wishing to exhibit implements, &c., are required to pay 5*s.* for their standing-room during the Show. This payment must be sent by a Post-Office Order made payable to the Secretary, and enclosed with the certificate: a neglect in making such remittance may invalidate their entry.

33. Implements which have been removed to the field must be brought back to the Yard, and replaced according to their numbers, either on the Tuesday evening or Wednesday morning in the week of the Show, by 6 o'clock.

34. No fire will be allowed to be lighted in the Show-yard for any steam-engine or other implement.

35. After the Consulting Engineer's Report on the implements has appeared in the Journal, a copy of that Report will be delivered gratis to such exhibitors of implements as may not be members of the Society, upon their making application for it to the Secretary, at No. 12, Hanover Square.

36. On Tuesday and Wednesday, in the week of the Show, the price of admission into the Implement Yard will be 2*s.* 6*d.*

37. Exhibitors of Implements will have a Free Ticket sent to them along with their "Admission Order."

38. The Judges' decision in all cases to be final.

39. Any person who shall have been proved, to the satisfaction of the Council, to have been excluded from showing for prizes at the exhibition of any society, in consequence of having been convicted of an attempt to obtain a prize by giving a false certificate, will not be allowed to compete for any of the prizes offered by the Royal Agricultural Society of England.

Instructions to the Judges.

The Judges will have the Friday, Saturday, and Monday previously to the Show for making their adjudication and signing their award.

The Judges will be instructed neither to divide nor to increase any of the specific prizes. If they should not award any specific prize mentioned in the Prize Sheet, they will be instructed not to appropriate that sum to any other description of implement.

If, in the opinion of the Judges, there should be equality of merit, they will be instructed to make a special report to the Council, who will decide on the award.

The Judges will be instructed to withhold any prize, if they shall be of opinion that there is not sufficient merit in any of the implements exhibited for such prizes to justify an award.

The Judges will be requested to observe that, in addition to the specific prizes, there are not exceeding Twenty Silver Medals, which they have the power of distributing in awards among the exhibitors of such miscellaneous articles as they may decide to possess sufficient merit.

The Judges will be instructed to deliver to the Director their *final* and *complete* award of all prizes and medals *before they leave the Yard*, on the evening of the Monday previously to the Show, in order that the necessary placards may be placed on the Prize Implements.

The Judges will be requested to observe that it is left to their discretion to select the implements for trial, and also to determine which of them shall be publicly exhibited at work in the field.

In making their decision, the Judges will be instructed to take the selling prices of the implements into consideration.

The Consulting-Engineer of the Society will be in attendance in the Implement Yard, and also during the private trials, to give his opinion as Mechanical-Referee when required by the Judges.

Instructions to the Stewards.

The Director and Stewards of the Implement Yard are instructed to take care that no Governor, Member (including the Council), or Stranger, be admitted into the Implement Yard before the Tuesday in the week of the Show. They are also instructed not to admit into

the Trial Yard, adjoining the Yard, any person excepting the Judges and the exhibitors during the trial of their respective implements.

The Stewards are empowered to make such regulations for the trial of implements as they may consider requisite; and previously to the time of the meeting to place the land which they may select under such culture and management as may ensure a fair and perfect trial.

The Stewards of the Yard, on receiving a notice in writing that any invention is considered to be an infringement of the right of another party, are instructed to inform the Exhibitor that he will be at liberty to direct the trial under the inspection of the Judges, and if on such trial his invention should be found to merit the prize, the prize shall be awarded, subject to the condition of payment being suspended for a reasonable period to allow the trial of the rights of the parties at law; and that if no steps at law are taken in the next term, the award shall be absolute.

The Director and Stewards of the Yard are requested to report the names of the parties who have not exhibited any of the Implements entered by them, or who neglect to pay the fines.

All Exhibitors' Servants in charge of Implements will be subject to the orders of the Director and Stewards.

The Council also delegates full power to the Director and Stewards to enforce all the above regulations.

*** All Exhibitors and persons admitted into the Show-yard shall be subject to the Rules, Orders, and Regulations of the Council.

PRIZES FOR ESSAYS AND REPORTS ON VARIOUS SUBJECTS.

1848.

All Prizes of the Royal Agricultural Society of England are open to general competition.

I. Farming of the North Riding of Yorkshire.

Fifty Sovereigns will be given for the best Report on the Farming of the North Riding of Yorkshire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the agricultural management.
3. The improvements effected in the farming of the North Riding of Yorkshire since the Report of John Tuke in the year 1800.
4. The improvements still required in the Riding generally, as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

N.B. The writers of County Reports are requested, if possible, not to exceed the length of 40, or at most of 50 printed pages.

II. Farming of the East Riding of Yorkshire.

Fifty Sovereigns will be given for the best Report on the Farming of the East Riding of Yorkshire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the agricultural management.
3. The improvements effected in the farming of the East Riding of Yorkshire since the Report of H. E. Strickland in the year 1812.
4. The improvements still required in the Riding generally, as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

III. Farming of the West Riding of Yorkshire.

Fifty Sovereigns will be given for the best Report on the Farming of the West Riding of Yorkshire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the agricultural management.
3. The improvements effected in the farming of the West Riding of Yorkshire since the Report of Robert Brown in the year 1799.
4. The improvements still required in the Riding generally, as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

IV. Farming of Gloucestershire.

Fifty Sovereigns will be given for the best Report on the Farming of Gloucestershire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the agricultural management.
3. The improvements effected in the farming of Gloucestershire since the Report of Thomas Rudge in the year 1813.
4. The improvements still required in the county generally, as to the higher culture of existing farms, the reclamation of waste lands, and the condition of the agricultural labourer.

V. Farming of Devonshire.

Fifty Sovereigns will be given for the best Report on the Farming of Devonshire.

Competitors will be expected to describe—

1. The character of the soils of the county.
2. The peculiarities of the climate.
3. The course of cropping in the various parts of the county.
4. The management of the orchards.
5. The formation and management of the water-meadows, both in the valleys and on the hill-sides.
6. The improvements which have been made since the Report of Charles Vancouver in the year 1808, and those which are still required.

VI. Cattle.

Thirty Sovereigns will be given for the best account of the Management of Cattle.

Competitors will be required to describe—

1. The various breeds of cattle.
2. Their respective merits for milking, working, and feeding purposes.
3. The various modes of breeding and rearing; of working; and of fattening.

VII. Lime.

Twenty Sovereigns will be given for the best Report on the use of Lime as a Manure.

Competitors will be required to state—

1. The kinds of soil to which lime is usually applied.
2. The properties of the various kinds of lime.
3. The mode of application, and quantity to be applied.
4. Its effect on various crops.
5. How far high cultivation supersedes the use of lime.

VIII. Grass-Land.

Thirty Sovereigns will be given for the best Essay on the Management of Grass-Land.

Competitors will be required to attend to the following points:—

1. Actual practice in management of downs and inferior pastures, meadows, and grazing-ground.
2. Time of applying manure.
3. Haymaking.
4. Consumption of after-grass.
5. Eradication of weeds and coarse grasses.

IX. Hops.

Twenty Sovereigns will be given for the best account of the best mode of Managing Hops, in its various branches.

X. Farm-Horses.

Twenty Sovereigns will be given for the best Essay on the Management of Farm-Horses.

Competitors will be required to attend to the following points:—

1. The various breeds.
2. Breeding and rearing.
3. Keeping, whether in stables or in the open air.
4. Feeding, in different seasons.

XI. Hemp.

Twenty Sovereigns will be given for the best Essay on the Cultivation of Hemp.

Competitors will be required to state—

1. The soils suited to hemp.
2. Mode of culture.
3. Mode of obtaining the fibre.
4. Average amount and value of crop per acre.

XII. Pleuro-Pneumonia.

Fifty Sovereigns will be given for the best Report on the Pleuro-Pneumonia amongst Cattle.

Competitors will be required to state—

1. Mode of infection.
2. Precautions against infection.
3. Premonitory symptoms.
4. Treatment of the disease.

These Essays must be sent to the Secretary, at 12, *Hanover Square, London, on or before March* 1*st,* 1848.

*** Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, and the subject of their Essay, and the number of that subject in the Prize list of the Society, shall be written.

4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of such Essays, not obtaining the Prize, as he may think likely to be useful for the Society's objects, with a view of consulting the writer confidentially as to his willingness to place such paper at the disposal of the Journal Committee.

6. The copyright of all Essays gaining prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate, at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.